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THE NEW ERA OF PROSPERITY.

A NOTABLE SPECIAL NUMBER OF THE ENGINEERING MAGAZINE.

THE newly-elected President of the United States has been heralded as "The Advance Agent of Prosperity." The campaign for his election was fought out on the pledge that his triumph would restore the prosperous conditions preceding the panic of 1893, and bankers, merchants, manufacturers, and business men generally, irrespective of party, united with the politicians in predicting that the defeat of free silver and the triumph of the gold standard would restore confidence, dissipate the gloom of uncertainty as to the future, and inaugurate a new era of prosperity.

As the campaign progressed and the success of the sound-money cause seemed more certain, we first saw panic driven from the stock exchanges by a steady and irresistible advance in values. Next came the news of an unprecedented increase in the volume of our export trade,—so great indeed that the available ships were inadequate to carry it, and in many instances freight rates were doubled. This was followed by heavy importations of gold, coming with every ship and measured by weekly aggregates of tens of millions of dollars. Then came the enormous advance in the price of wheat, showering happiness as well as profit upon American farmers, and forever dispelling the delusion that the price of that cereal is controlled by the value of silver. And finally, with the result of the election definitely known, we have seen the newspapers filled with despatches from every section of the country telling of the resumption of work by mills and factories of every description, giving profitable employment to hundreds of thousands of idle workers; the hoarded gold is still flowing into the banks; the treasury gold reserve is rising steadily; municipal bonds sell freely at high premiums; the rates for money have dropped to the

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normal point; and capital is freely advanced for every legitimate commercial and industrial enterprise.

This is cheering news, and happily there is enough of it to show that the discontent born of hard times must surely be dispelled by the logic of prosperity. But, after four years of panic and depression, prudent men are disposed to go slowly,—to ask for further information. Before large enterprises can be undertaken, before money can be laid out in needed extensions and improvements, there are leading questions yet to be answered. What are the underlying causes of the present prosperity? Is it due to the great natural laws of commerce and industry, and will it last? Or is it due to purely sentimental causes of temporary influence? Will the free-silver advocates be able to disturb confidence two years hence? Is the country in a healthy condition, commercially and industrially? What is the status of our great railroad systems? What is the outlook in the building world? Is the mining industry likely to be prosperous? What of the electrical field? And what are the prospects throughout the varied machinery-making and mechanical trades?

To meet the demand for information upon these and a score of kindred subjects, THE ENGINEERING MAGAZINE begs to announce, for its next issue, a special PROSPERITY NUMBER, the purpose of which will be to review the whole broad field of American economic and industrial affairs—present and prospective.

In this preliminary announcement it will not be necessary to indicate the scope and purpose of each article. Suffice it to say, that the matchless resources and grand opportunities of the United States as compared with all the older nations of the earth will be graphically set forth by one of the most eminent economists now living; the far-reaching significance of the advance in prices for farm products, and the recent importations of gold, will be clearly indicated by a statistician of the most distinguished attainments; and the outlook in each of the larger channels of industrial activity will be comprehensively reviewed by men of wide reputation, each of whom is in a position to intelligently forecast the probable conditions in his own field.

We are gratified in being able to promise a most stimulating array of facts in support of the wide-spread belief in coming prosperity, and we are especially gratified in having been able to draw to our aid for the occasion a corps of distinguished contributors, who will speak with such authority that the work is destined to play an important part in our industrial future. Indeed, it will be a volume of priceless value to every man of business who has money to invest, improvements or extensions to consider, or professional advice to be employed.

LABOR RIOTS AND SO-CALLED "GOVERNMENT BY INJUNCTION."

By Leonard E. Curtis.

ONE of the most vital issues of the presidential campaign which has just closed has received less attention than it merited, because of the over-shadowing importance of the main issue relating to the financial policy of the nation.

For the past twenty years labor disturbances have been among the most conspicuous features of our industrial development, and it has been a matter of increasing difficulty, in view of the magnitude of the interests involved and the bitterness of the passions aroused, to maintain law and order and at the same time hold an even hand in respecting the rights of the contending interests to enforce their demands by lawful means. One of the planks of the Democratic platform adopted at Chicago, which has been referred to as the "free-riot plank," related to this subject, and was intended especially as a denunciation of the method adopted by the federal government for dealing with a labor disturbance at Chicago some two years ago. As this matter does not seem to have been well understood, and as very many persons, even among those who heartily approved of the action that was taken, have been disposed to regard it with too much of an air of apology,—as a thing which had to be done, but which was in the nature of a war measure and really somewhat revolutionary in its character,—I have been asked to contribute to THE ENGINEERING MAGAZINE a discussion of the matter, with a view to explaining some points connected with it and leading those vitally interested in the question to examine it for themselves more carefully.

Some two or three years ago a labor organization known as the American Railway Union came into great prominence. It comprised in its membership a large proportion of the employees of a great number of railways, including the principal trunk lines extending from the Pacific as far east as Chicago, and some of those extending considerably farther east. Strikes of railway employees had been rather frequent prior to that time, but had for the most part been unsuccessful in enforcing the demands of the men; and this organization was formed on much broader lines, with the idea that concerted action on all the principal railways would give the employees control of the situation, and enable them to dictate terms to the railway companies. The leading spirit in this organization, and its president, was a young

man named Debs, a man of boundless ambition and audacity, and of considerable ability as an organizer and a demagogue. In the summer of 1894 a strike occurred at the works of the Pullman Company near Chicago, and Debs and his associates seized upon this with apparent avidity as a pretext for declaring war against the railway companies. The resulting disturbance was not, in the ordinary sense, a strike, since the members of the Railway Union did not profess to have any substantial grievance against the railway companies; it commenced, rather, as a boycott, the American Railway Union announcing to the railway companies that, unless the companies refused to haul Pullman cars on their trains, the men would quit work. This was, of course, a demand to which the railway companies could not yield, as Debs and his associates well knew, without practically putting the control of the railways into the hands of the employees. The railway companies were under contract with the Pullman Company to haul the cars, and the cars were necessary for their business; if they yielded to the Railway Union in this matter, which did not in any way relate to the wages of the men or their hours of labor or duties as employees, but to a matter of business management, they would have been obliged to yield in all other matters relating to the management of the roads. The officers of the railways accordingly refused to accede to the demands of the union, and a boycott was declared, which very soon assumed most formidable proportions; and the usual results —rioting, violent intimidation of new men, forcible obstruction to attempts to run trains, and destruction of railway property—ensued. Twenty-two great lines of railways centering in Chicago and running through various States of the Union were very soon practically stopped in their operations, and this resulted in great delay and, in some cases, absolute stoppage of the transportation of mails, passengers, and freight on the great through lines of railway.

For an account of the state of affairs which very soon existed we need go no further than the statements made by Debs and the other officers of the Railway Union, in a circular letter to the railroad companies, dated July 12, 1894, in which they say:

"The strike, small and comparatively unimportant in its inception, has extended in every direction, until now it involves or threatens not only every public interest, but the peace, security, and prosperity of our common country. The contest has waged fiercely. It has extended far beyond the limits of interests originally involved, and has laid hold of a vast number of industries and enterprises in no wise responsible for the differences and disagreements that led to the trouble. *Factory, mill, mine, and shop have been silenced; wide-spread demoralization has sway. The interests of multiplied thousands of*

people are suffering. The common welfare is seriously menaced. The public peace and tranquillity are imperiled. Grave apprehensions for the future prevail."

We also have a very striking statement of the ultimate purpose of Debs and his confederates, and the methods by which they expected to attain it, in an interview with Debs, published in the Chicago *Herald* of July 15, 1894, in which he said:

Throughout that great stretch of country which lies west of the Mississippi river our men are steadfast, and willing to wait until the bitter end. You will notice that *it is impossible to buy a ticket to the Pacific coast in Chicago* to-day, except by way of the Great Northern road, over which no Pullman cars are run, and against which we have no possible grievance. This shows the line on which our future campaign is to be carried. . . . We shall persist in our work of organization throughout the east. As a road throughout the country hitherto unorganized by us falls into line, we shall call it out. And we shall keep on doing this until the very end of all things. If our present struggle, based, as it is, on motives wholly disinterested, be successful, there is no wage-earner in the land who will not feel its beneficial effects before the year closes. And, if this is true, *when the command of the so-called 'arteries of commerce' falls into our hands*, and the trade unions which have given us comfort require reciprocation from us, we, and we alone, are in a position to give them material assistance. This is an axiom, and I believe no one will disagree with me."

Debs certainly does not here overestimate the value of the "reciprocation" he would be in a condition to give when he was once in command of "the arteries of commerce," since he would then have as firm a grip on the whole country as an invading army would have on the city of New York if it had possession of the Croton aqueduct. We should have had to dislodge him at once, or surrender. An interesting glimpse of the kind of government by "reciprocation" he would have given us is afforded by an order issued by his organization to haul Mrs. Leland Stanford's private car over one of the western roads at a time when it was not permitting the trains carrying ordinary people to their business and their work to run at all.

This was manifestly a wholly intolerable state of affairs, to which an end must promptly be put if life under the conditions of civilized society was to continue.

No one appreciates more fully than the engineer the desirability of using the simplest and most direct means of doing a thing that has to be done. If a line of railway is to be built between two points, the engineer naturally selects the shortest and most direct route, other things being equal; and, if motion is to be transmitted from one part

of a machine to another, the simplest and most direct connection between the parts is, other things being equal, the best.

The means chosen for putting an end to the Debs disturbance certainly left nothing to be desired as to simplicity and directness; in fact, the only complaint that has been made against what was done was that the means used were too simple and direct. The United States government had the matter brought by its proper law officers, in due form, before the federal court at Chicago having jurisdiction; the court issued an order called an injunction, commanding Debs and his associates "to desist and refrain" from interfering with, or obstructing, the transportation of the mails and the carrying of passengers or freight between or among different States; and, when proof was submitted to it that they had disobeyed the order, it sent out and got them and put them in jail, where they had no facilities for further disobedience.

A small detachment of the United States army, which had been ordered by the president to Chicago, stood by in this proceeding as a mere suggestion that seventy millions of people, most of whom were law-abiding, stood behind a chief executive who was determined to see that the constitution and laws of the United States were sustained. The bare suggestion was enough. No resistance was made to the marshals who arrested the leaders of the conspiracy.

As to the effectiveness of the means used for accomplishing the end desired, we can again appeal to the testimony of Debs himself, who testified before the United States strike commission as follows:

"As soon as the employees found that we were arrested and taken from the scene of action, they became demoralized, and *that ended the strike*. It was not the soldiers that ended the strike. It was not the old brotherhoods that ended the strike. *It was simply the United States courts that ended the strike.* Our men were in a position that never would have been shaken, under any circumstances, if we had been permitted to remain upon the field among them. Once we were taken from the scene of action, and restrained from sending telegrams or issuing orders or answering questions, then the minions of the corporations would be put to work. . . . The men went back to work, and the ranks were broken, and the strike was broken up, . . . not by the army, and not by any other power, but *simply and solely by the action of the United States courts in restraining us* from discharging our duties as officers and representatives of our employees."

The "minions of the corporations" here referred to were the thousands, and probably tens of thousands, of men who stood by, eager and willing to work as soon as the riotous intimidation organized and directed by Debs and his confederates should be ended; and the

"old brotherhoods" referred to were the Brotherhoods of Locomotive Engineers and Firemen, and other solid and respectable trade unions of the railway employees, which had, from the first, refused to have anything to do with Debs's dream of empire.

As Debs states, the action of the court ended the strike; the mobs dissolved, the men who stood waiting went to work, the railways resumed operations, the mails and inter-state passengers and freight were transported as before, the mills and factories that had been compelled to shut down for lack of supplies started up again, and the business of the country resumed its normal operation.

Debs and his principal confederates were soon afterward tried by the court without a jury (as has been the established usage in such cases from time immemorial) for disobedience of the injunction order, and the court, after a full trial and the examination of a great mass of evidence, found them guilty and sentenced them to imprisonment for terms varying from three to six months. The matter was taken to the supreme court on *habeas corpus* proceedings, and that court unanimously sustained the decision of the circuit court. The defendants got out of jail in ample time to take part in the last campaign on the Bryan side, and the result of the election, especially in Illinois, where Altgeld was a candidate for governor and made this a very prominent issue, may fairly be taken as a most emphatic popular verdict in approval of the action of the courts.

Enough has been said, I think, to make out at least a *prima facie* case for the use of the injunction in such matters; but there may, of course, be another side. Just as in the work of the engineer the shortest line for a railway may not be the best one on account of its involving heavier grades or greater cost than a longer one, and a simple and direct connection between two moving parts of a machine may be incompatible with the proper working of other parts, so it may be that there are fatal objections to such use of injunctions. It was most vehemently asserted in the last campaign that there are such objections, and that the action taken by the United States government and the courts in the Debs cases was revolutionary in its character, and would inevitably lead to the subversion of liberty and the destruction of free institutions. If this is true, proper measures should be taken promptly, by proper legislation, or by amending the constitution, if necessary, to prevent such action in the future. Let us see if it is true.

As Governor Altgeld was the chief exponent of these views and summed up all that could be said on that side in his recent speech at New York, I will touch briefly on the salient points of the argument presented by him. A large part of the speech is taken up with a labored attempt to show that there was not in fact any interference at

Chicago with the mails or with inter-state commerce such as would justify the interference of the federal government, and that the disturbance was a purely local or domestic one, with which the State authorities should have been left to deal. This is entirely aside from the present question as to whether, conceding the difficulty to exist, the method employed for dealing with it was a proper one; but, as a matter of fact, it is not true that the difficulty did not exist. As opposed to Governor Altgeld's assertion, we have what we have already quoted from Debs and the unanimous decision of several circuit judges and the nine justices of the supreme court, given after careful examination of a great mass of evidence, that such interference did in fact exist to a most alarming extent.

Aside from this question of fact, the arguments Governor Altgeld attempts to make may be summarized substantially under two heads: *first*, that it was unconstitutional for the president to interfere, either throught the federal courts or by sending the United States troops to the scene, without the request of the State authorities, because the disturbance was "domestic violence" such as the State authorities should be left to deal with in the first instance; and, *second*, that the method chosen for dealing with it—that of issuing an injunction and then punishing Debs and his associates when they violated the injunction, after a trial by the court alone—was also unconstitutional and subversive of liberty, since it denied the right of trial by jury guaranteed by the constitution, and substituted for it "government by injunction," under which all of the affairs of life would "soon be regulated, not by law, but by the personal pleasure, prejudice, or caprice of a multitude of judges." The first of these propositions ignores the very foundation principles of the dual system of government established by the constitution, under which certain functions of government are assigned specifically to the United States and others reserved to the several States, and each government—the federal and the State—acts directly upon the citizens themselves, as to the function assigned to it, through its own machinery of courts, officers, and military power, without reference to, or dependence upon, the other.

The constitution expressly provides (Art. VI) that "this constitution, and the laws of the United States which shall be made in pursuance thereof, shall be the supreme law of the land," and in Article I, Sec. 8, it is provided that "the congress shall have power . . . to regulate commerce with foreign nations and *among the several States*," and "to establish post-offices *and post roads*."

In Article III provision is made for the establishment of courts of the United States which shall have jurisdiction over all cases arising under the constitution and the laws of the United States, and these

courts, of course, have jurisdiction over all cases arising under the laws of the United States relating to inter-state commerce and the transportation of the mails.

Congress had, prior to the Debs riots, exercised the power thus given by passing various acts establishing the post-office system and providing for the transportation of the mails, and also regulating commerce among the States and prohibiting obstruction of it. Among other things it had declared the railroads involved in Debs's operations to be post roads for transporting the mails. To say that a disturbance at Chicago which stopped or delayed the transportation of mails between New York and San Francisco, and the transportation of passengers and merchandise between Minneapolis and New Orleans, was a disturbance purely "domestic" to Illinois is manifestly absurd. The persons engaged in it were violating *federal* statutes, and it was not only the right, but the duty, of the federal government to stop all violations of these statutes, and to use its own machinery for that purpose without waiting for the request or permission of the State authorities. As Chief Justice Marshall says, in delivering the opinion of the supreme court in an early case:

"*No trace is to be found in the constitution* of an intention to create a *dependence of the government of the Union on those of the States* for the execution of the great powers assigned to it. *Its means are adequate to its ends; and on those means alone was it expected to rely for the accomplishment of its ends.* To impose on it the necessity of resorting to means which it cannot control, which another government may furnish or withhold, would render its course precarious, the result of its measures uncertain, and create a dependence on other governments, which might disappoint its most important designs, and is incompatible with the language of the constitution."

The same considerations apply to the use of the federal courts as to the use of the federal troops for the purpose of suppressing disturbances involving violation of the federal statutes. I will only say, in passing, that, upon his own showing, Governor Altgeld has the same facilities under the constitution of Illinois for establishing a military despotism in that State that the president has under the United States constitution, according to the interpretation of it under which Mr. Cleveland acted, for doing the same thing in the whole country. The governor of Illinois has power in his discretion to order the State troops to any town upon the application of any one of half a dozen officers, and he could readily get such an application from some one of them if he desired it. It is merely a case of entrusting large powers to the discretion of an executive officer where some one must have the power to act promptly in an emergency.

The provision of the constitution to which Governor Altgeld refers as requiring the president to wait for an application from the State authorities is one entirely separate from those referred to, and has no bearing on the facts presented by the Chicago riots. It provides in substance (Art. IV, Sec. 4) that the United States shall protect each of the *States* against "domestic violence" upon application of the State authorities. The "domestic violence" here referred to is manifestly such violence as concerns only the inhabitants of the particular State by violating State laws only, and does not involve the rights of the people of other States. It is "violence" directed against the State in its "domestic" government. It is clear that the Chicago riots were not mere "domestic violence" in this sense.

Nor is there any merit in Governor Altgeld's argument in regard to the extraordinary nature of the means used for suppressing the riots. It seems, from what he and others have said on this subject, as if the writ of injunction were something new and unheard of, or, at any rate, that its application to such purposes was so extraordinary as to be entirely revolutionary in its character. As a matter of fact, the writ of injunction formed a part of the system of English jurisprudence for at least two hundred years before the colonies forming the United States separated from the mother country. It was borrowed by the English law from the Roman law, of which it formed a part some two thousand years ago, and it has been a part, and a necessary part, of the system of jurisprudence of every civilized country. Without it no adequate remedy could be supplied by the law for wrongs of a very serious nature. If my neighbor comes on my place and cuts down fruit trees or ornamental shade trees which it would take a generation or two to replace, or if a railroad company takes violent possession of my house which is endeared to me as a house by family associations and tears it down to make room for its tracks, it is no adequate compensation to me to have the offender fined and imprisoned or compelled to pay me a sum of money as damages. What I need for adequate protection is the *prevention* of such injuries, and not compensation for them. No more striking instance of this could be furnished than was furnished by the operations of Debs and his confederates. They were paralyzing the business affairs of millions of people, and it would be no adequate compensation to those injured to have Debs imprisoned or compelled to pay damages. What was imperatively needed was an immediate ending of Debs's unlawful operations, and this result could have been accomplished only by the action taken by the court, or by suppressing Debs and his confederates by military force.

It is to be observed, further, that the injunction is far more necessary as a part of the machinery of the courts for protecting the weak

against the strong than for protecting the strong against the weak. Great corporations or rich men of great resources can usually protect themselves against unlawful interference with their property rights, but it is not so with the man of small means, and for him the summary interposition of the courts is essential when his rights are threatened. In this case the principal sufferers from Debs's operations were not the railway companies, but the multitudes of train men and others who desired to work on the railways, but were prevented by intimidation, and the other multitudes of workmen who were thrown out of employment by the shutting down of mills and factories for lack of transportation facilities.

Nor is it true that the use of the injunction in the manner in which it was used in the Debs case was at all extraordinary or unusual in any proper sense of those terms. The United States constitution provides (Art. III) that the judicial power of the United States shall be vested in the supreme court, and in inferior courts that congress may establish, and that "the judicial power shall extend to all cases in law *and equity* arising under the constitution, the laws of the United States," &c. Under this provision of the constitution, the United States courts have, from the foundation of the government, exercised the ordinary powers of the courts of equity to restrain by injunction interference with commerce between the States when conducted by water, and have granted and enforced injunctions prohibiting obstructions to rivers and other water-ways. While it is true that the courts have not until recently exercised these powers at all frequently with reference to transportation by railways, the application of this method of dealing with obstructions to inter-state railway traffic certainly forms no new departure. As the supreme court says in the Debs case:

"Constitutional provisions do not change, but their operation extends to new matters, as the modes of business and the habits of life of the people vary with each succeeding generation. The law of the common carrier is the same to-day as when transportation on land was by coach and wagon, and on water by canal-boat and sailing vessel; yet in its actual operation it touches and regulates transportation by modes then unknown,—the railroad train and the steamship. Just so is it with the grant to the national government of power over inter-state commerce. The constitution has not changed. The power is the same. But it operates to-day upon modes of inter-state commerce unknown to the fathers, and it will operate with equal force upon any new modes of such commerce which the future may develop."

Nor is there any merit in the objection that the method of dealing with Debs and his confederates takes away the right of trial by jury guaranteed by the constitution. The constitution does provide (Art.

III, Sec. 2) that "the trial of all *crimes* . . . shall be by jury"; but the offence for which Debs and his confederates were tried and punished was not a "crime" within the meaning of that term as used in the constitution,—that is to say, the violation of a penal statute,—but it was an entirely different offence, well recognized in the English system of law which prevailed in the mother country long before the separation of the colonies from it, and known as "contempt of court." The offence consisted, not in the violation of any penal law, but in disobedience of the court's orders, and it has been, from the earliest times, recognized as a necessary power of a court that it should have, of itself, the power to punish summarily all violations of its own orders. Without this power the court would be, in many cases, a mere mockery. Of what possible use would it be for a court to make an order directing a thing to be done, or prohibiting its being done, if the order could not be enforced? In most cases of this kind a jury trial would be a most inadequate means of enforcing such an order. This very case affords a striking instance of this. It was stated at the time, apparently on good authority, that Debs and his confederates had made elaborate preparations to furnish bail as soon as they were arrested anywhere on any charge, and to go on with their work of obstructing railway traffic, relying upon the slowness of the machinery of the criminal law to give them time to get such a foothold that they could defy the courts. It was only the summary interposition of the courts and the prompt use of the ample powers they possessed for enforcing their orders that enabled them to thwart this plan.

Nor is there any real ground for apprehension that any of the evils which Altgeld and his friends picture in lurid language as certain to come from confiding so great powers to the discretion of one man will really happen. It is not true, as they say, that it is a most extraordinary thing to give great powers in important matters to a single man; on the contrary, it is the most common thing possible in the ordinary affairs of civilized life. The officer in charge of a great steamer, when he sees another steamer approaching on the opposite course, has to decide whether he will go to port or starboard, and he must decide this himself and at once. There is no time to call a meeting of the board of directors or empanel a jury of the passengers to determine the question. If he acts in a critical moment from "whim, prejudice, or caprice," as Altgeld assumes that the judges will act, he may send both steamers to the bottom and destroy thousands of lives and millions of property. No locomotive engineer can make his daily run without having similar questions constantly presented for his immediate decision where a wrong decision is fraught with similar disastrous con-

sequences, and even a switchman has similar responsibilities constantly thrust upon him. Most impressive proof of the fact that men having great powers over life and property do not, in fact, act from "whim, prejudice, or caprice," but are governed by fidelity to duty, is presented by the every-day occurrence of the safe arrival of an express train running, say, from New York to Chicago. We do not often stop to think of the vast multitudes of men engaged in the construction of the permanent way and the equipment, and in operating the road, any one of whom might, if he acted as Altgeld assumes that our judges do, wreck the train. Shall we have less confidence in the sense of duty of a picked body of highly-trained men like our judges than in track-layers and switchmen?

Precisely the same reason exists for giving judges great powers in granting injunctions, as in the case of the men I have referred to; somebody must decide at once, or the occasion for action will pass. To be of any service, an injunction must be issued and enforced at once, or the harm it is intended to prevent will be done.

But it may be objected that the officer in charge of a steamer and the locomotive engineer are not left to act on their own unfettered discretion, but are subject to rules regulating their action quite rigidly. Precisely the same thing is true of the judges; they are hedged in by long-established rules governing very minutely their actions in granting injunctions, and the violation of these rules renders them liable to impeachment.

There is another conservative force of a most potent character restraining judges in such matters. Professional men are peculiarly sensitive to the criticism of men of their own profession. The most unscrupulous and audacious judge would hesitate a good while before he would take any action which other judges and the members of the bar would consider illegal or even foolish. Professor Maine, in his work on "Ancient Law," gives a very striking instance of this. Under the Roman law the prætor, who corresponded to our chancellor or equity judge, was not controlled by any statutory law, but issued each year, when he took office, an edict or proclamation declaring the manner in which he intended to administer his court and the rules he intended to follow. Theoretically any new prætor might revolutionize the entire system of equity jurisprudence, but, as a matter of fact, each one adopted what his successor had done, with an occasional amendment, and the whole system remained singularly stable for some centuries. In explaining the causes of this remarkable result, Professor Maine, referring to the prætor, says:

"The checks on his apparent liberty are precisely those imposed on an English judge.

"Theoretically there seems to be hardly any limit to the powers of either of them, but practically the Roman prætor, no less than the English chancellor, was kept within the narrowest bounds by the prepossessions imbibed from early training, and by the strong restraints of professional opinion,—restraints of which the stringency can only be appreciated by those who have personally experienced them."

But perhaps the most conclusive answer to the fears expressed by Altgeld and other champions of liberty unfettered by injunctions is to be found in the experience of the civilized world as to what has actually happened on this point. It is to be observed that the arguments used relate to injunctions generally, and are not based upon anything peculiar to the granting of injunctions by the federal courts. Now, I venture to say that not a working day passes during which hundreds of injunctions are not issued and enforced by the various State and federal courts of this country, and not only is this true of the present time, but the same condition of affairs has existed since the foundation of the government. More than this, it exists, and has existed for a long time, in all civilized countries in the world. Yet, in spite of all this, none of the evils in regard to which so grave apprehensions are expressed have, in fact, followed. Neither this country or any other civilized country is, or ever has been, governed by the "whim, prejudice, or caprice" of judges by making improper use of their powers to grant and enforce injunctions. Nor is there any ground for apprehension that this state of affairs will be changed by any change in the character of our judges. The federal judges of this country are, and always have been, men of exceptionally high character and ability. As to integrity, learning, laborious care in their work, and fidelity to duty, they stand higher to-day than the judiciary of any other country, and I think no reasonable man can find any just cause for apprehension that they will abuse the great powers necessarily committed to them.

It may be pertinent to ask what other method the critics of the use of the injunction have to suggest for dealing with such difficulties as the Debs strike. As I have already shown, Debs and his associates were an obstruction to civilized life that had to be removed, and removed promptly. There are only two other methods than the one employed which suggest themselves to me for accomplishing this result. A counter mob might have been assembled to disperse the Debs mob, and this would certainly have been resorted to, if lawful methods of dealing with the difficulty had not been found; but it would clearly have been a reversion to barbarism. The other method consists in the use of military force. As the disturbance had gone far beyond the powers of the ordinary police force to deal with it, it would have been

necessary to use either State or federal troops (and for the purposes of the present point it makes no difference which) to disperse the mob organized by Debs, and, in view of the extreme bitterness with which the contest was conducted by Debs and his confederates, it is quite apparent, in the light of our experience in such matters, that the troops would sooner or later have been compelled to fire into the mobs. This certainly is not a method which ought to be resorted to, unless all other lawful methods fail. In this connection I observe that Altgeld complains with much bitterness that some four hundred men, besides Debs and his immediate associates, were arrested for disobedience of the court's orders, and were afterward discharged because nothing could be proved against them, and that some of these men were taken a considerable distance away from their homes for trial and were so poor that they had to walk home and beg their way. While this does seem to involve hardship, yet the hardship was clearly not so great as if these same men had been killed by shots fired into the crowds by troops. The *rôle* of an innocent spectator of mob violence is always a hazardous one, but the hazard is certainly not as great when injunctions are used to disperse the mob as when bullets are used for that purpose.

I think men of plain common sense will have no difficulty in agreeing with the supreme court, when it says in the Debs case:

"Indeed, it is more to the praise than to the blame of the government that, instead of determining for itself questions of right and wrong on the part of these petitioners and their associates, and endorsing that determination by the club of the policeman and the bayonet of the soldier, it submitted all those questions to the peaceful determination of judicial tribunals, and invoked their consideration and judgment as to the measure of its rights and powers and the correlative obligations of those against whom it made complaint. And it is equally to the credit of the latter that the judgment of those tribunals was by the great body of them respected, and the troubles which threatened so much disaster terminated."

It is true, as Altgeld says, that the power to issue injunctions has been abused; but this is true of all powers confided to officers of the government, or to any one else, and the abuse of the power to issue injunctions has, under all the circumstances, been extremely small. The courts did, in this very class of cases, go too far at one time by forbidding men operating railways in the hands of receivers appointed by the courts to quit work; but this was immediately corrected, and in the Debs case, at any rate, no such question arose, the supreme court saying in its opinion that "the right of any laborer, or any number of laborers, to quit work was not challenged."

There is also some force in the objection to what are called "blanket injunctions,"—that is to say, injunctions addressed generally to large numbers or classes of men whose names are not given,—but it is not true, as is asserted, that there is anything new or extraordinary in this. On the contrary, it has for a long time been customary, in cases of conspiracy like the Debs case, to include in the injunction all the confederates of the principal parties named, without naming such confederates. It is a form of injunction, however, liable to abuse when applied to cases of this kind, and which should be resorted to only in great emergencies. I think the federal judges can be relied on to restrict its use within proper limits.

It is not considered by the managers of a railway a valid objection to the equipment of passenger-cars with quick-action brakes that a foolish engineer may make improper use of them by making an emergency-stop every time a dog crosses the track in front of him, and shaking up the passengers unnecessarily. Railway managers are practical men, and they get the best modern equipment for their roads, for use in emergencies as well as under ordinary conditions, and rely on their men to use it properly. The same principle applies to the government. We want our government provided with the best possible modern equipment for maintaining law and order in emergencies as well as in ordinary affairs, and we can rely on our judges to use it properly.

No one has a deeper interest in this than the wage-earner, because he, more than any other man, depends for his prosperity upon the absolute and continuous maintenance of peace and good order. His labor, which is the only thing he has to sell, is the most perishable of commodities. If the owner of a bushel of wheat or a yard of cloth does not sell it to-day, he can keep it for sale to-morrow, but it is not so with the wage-earner. If the labor of to-day is not done and is not disposed of for the wages of to-day, its value for the wage-earner disappears utterly and is lost. To-morrow is another day, and its labor brings other wages.

The direct loss caused by the Debs strike to the wage-earners of the country, even as it was, reached millions of dollars, but this was a mere bagatelle compared with what the wage-earners would have lost, if the disturbance had not been promptly suppressed.

SIX EXAMPLES OF SUCCESSFUL SHOP MANAGEMENT.

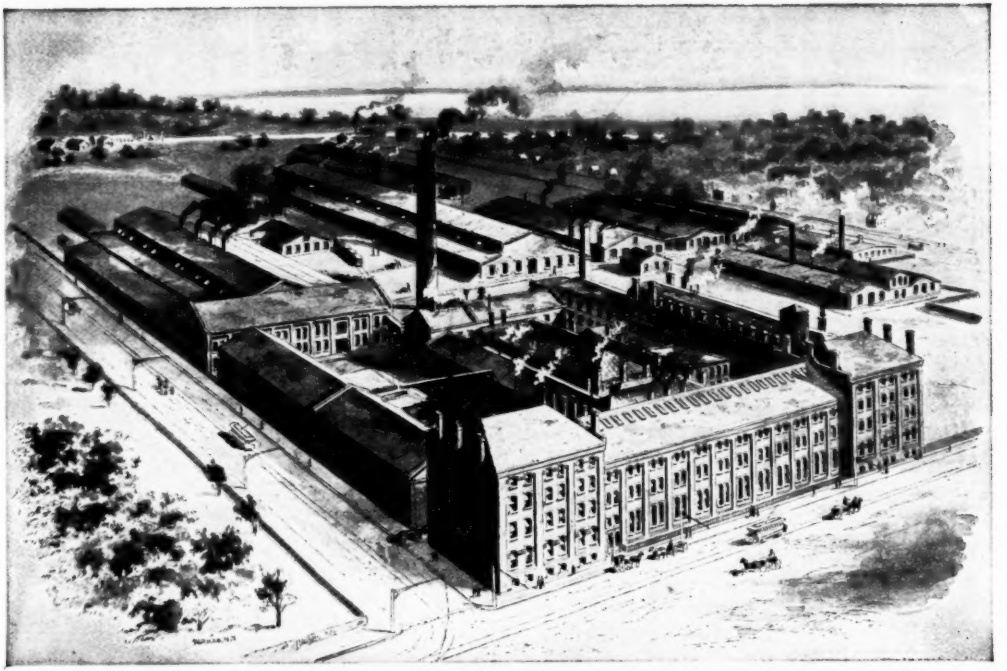
By Henry Roland.

III.

THE dealings of the Whitin Iron Works and the Cheney Silk Mills with labor are marked by an absence of fixed method and a general policy of individual treatment in which special hardships are alleviated by the special means that may seem best fitted to the case.

The Yale & Towne Manufacturing Company reaches success by the opposite course of precise law and rule, framed with infinite labor and minuteness of detail to cover every case which can possibly arise. These laws, rules, and regulations may, I think, be justly said to be wholly the work of Mr. Henry R. Towne, the president of the company, and I think, also, that it is true that his personal attention has been so minutely directed to every detail of the manufacturing operations of his concern, and that, joined to this, his executive ability is so commanding that his own conception of what is correct governs every movement of the workmen in their working-hours, and that the success of the enterprise which, under the name of the Yale Lock Company, started under his sole management in 1868 with less than thirty hands, and having now a pay-roll of about 1,400 names, may be said to belong to him personally and individually. It is, of course, true that he has been ably and indispensably assisted by those in responsible positions under him, and that the foundation of the business was and remains the improvement in the art of lock making embodied in the inventions of Linus Yale, Jr., who died in December 1868. Yet the business in all its details has been so thoroughly permeated by Mr. Towne's everywhere-present personality, that the success of the company may be truly said to be wholly his creation.

Linus Yale, Sr., who was an inventor and mechanic of general merit and wide ability, employed some twelve or fifteen men at making pin-tumbler bank and safe locks at Newport, Herkimer Co., New York, and his son, Linus Yale, Jr., had just established a factory for the production of locks of the same character at Shelburne Falls, Mass. Linus Yale, Jr., had a strong leaning towards art, and began as a painter. He was familiar with the work in his father's shop, and the absorbing fascination of the endless problem of the lock soon caused him to abandon the easel for the work-bench. His first venture in business



FACTORY OF THE YALE & TOWNE MANUFACTURING CO.

THE TOOL ROOM.

for himself was in Philadelphia, but he soon removed to Shelburne Falls, where he employed about fifty men in 1866 on high grade pin-tumbler and bank locks and his "double treasury" lock. This "double treasury" lock was a very peculiar construction, weighing about 62 pounds, selling for $450, and having a key with separable bitts which, in the process of unlocking, left the key shank, travelled a considerable distance away from it, arranged the tumblers in unlocking position, and finally returned to the key shank and reunited themselves with it, as the bolt was withdrawn. In 1868 the Shelburne Falls establishment had thirty or forty hands, and two sons of Linus Yale, Jr., were in the shop. It was at this time that Mr. Yale and Mr. Towne entered into business relations. Mr. Towne had had a thorough engineering training; his father had been associated with I. P. Morris in the Southwark Foundry, Philadelphia, and Henry R., at that time only twenty-four or twenty-five years of age, had been through the shops, was a skilful and thorough draughtsman, and had received a general scientific education. Mr. Yale had made a great advance in the theory of lock-making by separating the parts of a lock according to the office filled by each, grouping the tumbler mechanism in a "cylinder" forming a distinct part or structure, and the bolt and case in another, and had greatly reduced the size, thickness, and weight of the key for operating the "Egyptian," or pin-tumbler, lock. This

pin-tumbler lock is one of the oldest known, but in its earlier forms had a cumbersome key, and, although familiar to the early German and English lockmakers, had never been recognized as holding commanding possibilities. European lock-makers relied upon warded locks up to Barron's invention of the lever tumbler; the warded locks had large and elaborate keys; the Barron tumbler made a much smaller key possible; and later still Bramah invented the sliding radial tumbler, which had a very small, light, cylindrical key, and gained great favor. A little later Chubb rivaled Bramah with a new improvement in lever tumbler-locks, and Bramah and Chubb in Europe, and Yale, Sr., with his modification of the Egyptian lock, in America, represented the leading advances in the art of lock-making at the time Yale, Jr., came upon the field, and, by making a small, thin, flat key suitable to control the movements of the pin-tumblers of the ancient Egyptian locks, laid the foundation for a new line of manufacture, which so favorably impressed young Towne that he resolved to identify himself with its development. A partnership was formed in October, 1868. Stamford, Conn., thirty miles east of New York, was selected as a suitable location, and Mr. Towne at once began the planning and erection of the new factory. In December, 1868, Mr. Yale, who was still carry-

A MODEL MAKER AT WORK.

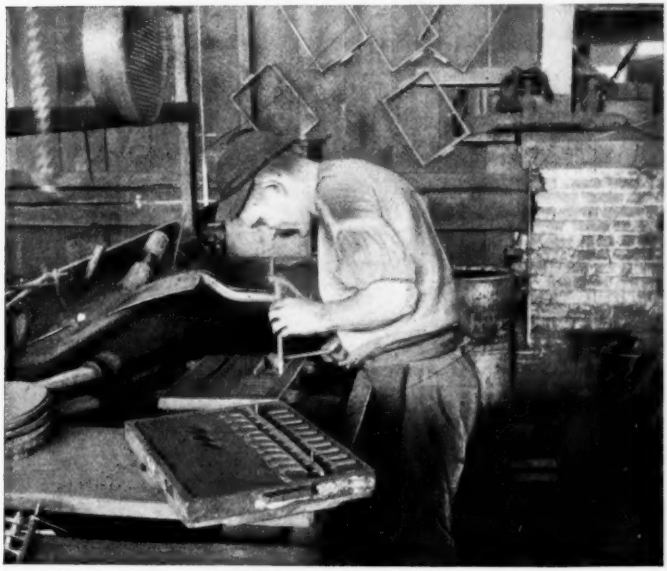
METAL PATTERN MAKING.

ing on the Shelburne Falls business, died suddenly of heart disease at a New York hotel; Mr. Towne proceeded with the shop at Stamford, and in March, 1869, with the assistance of John B. Yale, son of Linus, Jr., the Shelburne Falls plant was removed to Stamford, and the new shop was put into operation with about thirty hands. In June, 1869, the company was incorporated with $150,000 capital, and Mr. Towne chosen president; in 1870 the entire Yale interest was acquired by Mr. Towne; in 1881 the capital was increased to $500,000, and again in 1883 to $1,000,000, at which the share capital still stands, although the invested capital is more than twice that amount.

When the Stamford works began operations in 1868-9, wages in America were at their highest point, although gold had fallen considerably from its highest premium. Tool-makers' pay was $3.00 to $4.00; moulders', $3.00; lock-makers', $2.25; boys', $1.00 to $1.25 per day. These high rates could not possibly continue; they were due directly to the depreciated currency values incidental to the suspension of specie payment during the war of the rebellion, and consequently demanded readjustment as the value of greenbacks appreciated. From the first the tool-makers had formed the only large class of day-pay

IRON MOULDING WITH MACHINE.

workers. Tool-making in the Stamford shops has always been carried to the utmost limit of economy, and the force of tool-makers has consequently been very large. The moulders were, from the first, individual piece-workmen, and production of work for sale was effected by the contract system, New England style, the contractors hiring and discharging their own men, and receiving a fixed piece-price for finished work. The workmen made their day-pay, no more and no less, except sub-contractors, who undertook portions of a principal contractor's work and supervised the labor of a limited number of hands. The principal contractors made from $2,000 to $4,000 yearly, which is, or was (as the contract system is disappearing), about the usual New England rate of contractor's earnings. The contractor's pay depended entirely on his ability to get work out of men. If a contractor could furnish brains and energy to sixty or seventy men, so that each one should do his work in the most intelligent manner and shortest space of time, he could, of course, make better pay than a less capable contractor, who could manage only, say, ten or fifteen hands. It is still an open question whether or not the contract system produces the cheapest and best work, and this question will probably not be soon determined, as the contract system is in disfavor, and is being gradu-



BRONZE-MOULDING BY HAND.

ally, but constantly, discontinued. In one case within my own knowledge a very able contractor who "runs" from sixty to ninety men divides his gains in excess of $5,000 yearly evenly with the management. In most cases the effort now is to replace the contractor by fixed-pay foremen, and to put the hands on piece-rate pay, thus exactly reversing the former method of paying the hands by the day and the contractor by the piece.

In spite of the constant fall in the prices of all other commodities, the first avowed cut in wages was made in the Yale & Towne shops in 1876, eight years after starting. This cut took the form of a flat reduction of fifteen per cent. on all fixed-rate pay in the establishment; it was made at a time when the shop was short-handed, having only about one hundred and seventy-five men at work on short time. This cut was fully recognized by the workmen as just and necessary, and was accepted without remonstrance. Another reduction of ten per cent. was made in August, 1893; the shop was running full-handed and on full time, but, in spite of these evidences of shop prosperity, the hands believed the reduction justified, and again accepted the cut without question. In fact, there has never been any money trouble between the management and the workmen at the Yale & Towne

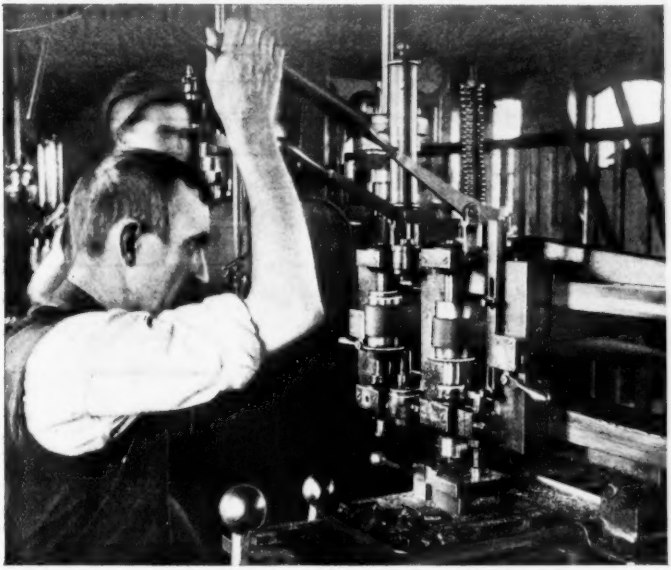
IN THE CORE ROOM.

shops, though the rates for piece work have been steadily reduced from the day the shop started until now.

The only real trouble with hands began through the determination of one moulder to wash up in his own bucket, on his own floor. From the very first Mr. Towne's management has included extreme neatness as a prominent feature. The yards inside the works are perfectly clean, not a dead leaf or a scrap of paper being allowed to lie on the ground. Lavatories are abundant through the shops, and are in many cases in the form of individual wash-bowls, and the use of the well-appointed washing facilities is not optional with hands, but obligatory. Fine brass castings, or, rather, the very finest of brass castings, are absolutely essential to the economical production of the Yale & Towne manufactures, and, as a consequence, the establishment has a force of extremely skilful brass moulders, who are, of course, fully aware of their own importance and value. It had been the custom of the moulders to wash up in buckets, every man in his own place. The management provided an elevated lavatory with washing-troughs, suspended from the roof, reached by stairways, and bringing a man's head about twenty feet above the floor when he stood at the washing-troughs. Pouring is continuous, from 9 A. M., in the brass foundry,

and the atmosphere twenty feet above the floor is always unpleasant, especially in warm weather. The moulders are allowed ten minutes for washing up, which is their own time, as they are individual piece-workers. On June 28, 1890, one of the moulders began to wash up in his own bucket on his own floor at 5.50 P. M., as he preferred this to the lavatory conditions. The foreman remonstrated; the workman was obdurate; the foreman told the workman to take his "blue ticket" (full-time pay and discharge) to the office; and the workman said he would do so, and, having thus become an independent citizen, he delivered a very frank opinion to his former superior officer, and left the place, to all appearance in peace.

Next morning, however, the twenty-eight remaining moulders struck against the lavatory. This was serious, as the moulders could not be easily replaced. The best help that could be obtained was hired in, and, as there had been threats made, was guarded and lodged on the premises. The strikers organized, and had a "labor delegate" up from New York to confer with the management, without effect. The brass castings were poor, and on July 15 the entire plant was shut down. About August 15 a deputation of the chain-makers sent in a petition to have the works reopened. Public sentiment was against



FINISHING PADLOCK CASES IN EDGING MACHINE.

the moulders, who fell immediately into line with the chain-makers, and the works were reopened, each man filling up and signing the following application and contract, which the management esteems perfectly fair and impartial, and under which every hand in the Yale & Towne Factory is now employed.

7360-10.95-10

THE YALE & TOWNE MANUFACTURING COMPANY

APPLICATION FOR EMPLOYMENT.

The undersigned hereby makes application for employment in the Works of THE YALE & TOWNE MFG. CO., and submits the following statement of facts:

Name, _____

Where born, _____ *Age*, _____

Address, _____

Occupation, _____

Last employed by _____

Address, _____

From _____ *189* , *to* _____ *189*

Previously employed by _____

Address _____

From _____ *189* *to* _____ *189*

Do you belong to any organization or association which would prevent your honorably carrying out the terms of the within contract? _____

If so, what is its legal title? _____

**Do you agree not to join any organization or association which would prevent your honorably carrying out the terms of the within contract?* _____

Married or single? _____ *Family* _____

This is a True Statement.

_____

In the presence of

_____

* These questions are simply for the information of the Company, and are not intended to curtail the right of the applicant to belong, now or later, to any reputable organization.

Labor and Capital are Co-Partners; neither can prosper without the other; the injury of one should be the concern of both.

CONTRACT

BETWEEN

THE YALE & TOWNE MFG. COMPANY,

AND

THE YALE & TOWNE MANUFACTURING COMPANY, as one of the parties of this contract, hereby agrees with other party hereto as follows:

(1.) To punctually pay all wages or other earnings.

(2.) To have due regard for the rights and the reasonable convenience of employees.

(3.) To exercise reasonable care for the health and comfort of employees in all sanitary arrangements.

(4.) To give due consideration and prompt reply to requests, properly presented by employees, relating to matters which affect their welfare, and which are within the Company's control.

(5.) To fairly adjust with each employee, individually, the wages or other compensation, and to review this adjustment at reasonable intervals, if so requested.

(6.) To give a certificate of honorable discharge, if so requested, to any employee entitled to it who has been not less than six months in the Company's service.

THE YALE & TOWNE MFG. COMPANY.

By_____

PAYMASTER.

IN CONSIDERATION OF employment by THE YALE & TOWNE MANUFACTURING COMPANY, and the covenants on the part of the latter herein set forth the person above-named hereby agrees with said Company as follows:

(7.) To faithfully render the service which is undertaken and for which the Company pays.

(8.) To conform to the shop rules and carry out instructions received from the Foreman or the Officers of the Company.

*(9.) In case any reasonable ground for complaint exists, to report the facts, first to the Foreman, and if no redress is thus obtained, to bring the matter, preferably in writing, to the notice of the Company, through the Paymaster or one of its Officers.

*(10.) To take no action of any kind, individually, or with others, tending to cause disturbance of the relations between the Company and its employees, because of any grievance, until the matter has been first submitted to the Company in the manner indicated in Article 9, and, if said request, so presented, is not granted, to take no action tending to harass or injure the Company until at least fifteen days shall have elapsed after such request has been presented to the Company without its taking action thereon.

(11.) To withdraw and abstain, during the period of this contract, from membership in any organization whose rules would prevent the honorable carrying out of this contract.

(12.) To forfeit to the Company, as liquidated damages, a penalty or fine equal in amount to one week's wages or earnings, in event of any violation of Articles 10 or 11 of this contract.

*In Departments A and B, complaints under Articles 9 and 10 are to be made in the first instance to the Foreman or Contractor; if not acted on within three days, then to the Dept. Superintendent; if not acted on by him within three additional days, then to the Company as per Article 9.

STAMFORD, CONN., ...189

RIGHTS.

The following rights are to be mutually recognized and respected by each of the parties to this contract, the Company acting through its Superintendents, Foremen, Contractors or other authorized agents

(1.) The right of the Company to employ whom it desires.

(2.) The right of the Company to discharge without notice any Employee violating its rules or the terms of this contract.

(3.) The right of the Company to discharge any Employee whose services are not satisfactory, or not needed.

(4.) The right of the Company to decline giving employment to members of organizations whose management or policy the Company believes to be antagonistic to its interests.

(5.) The right of the Company to discharge any Employee found guilty of misstatement of facts in this application for employment.

(6.) The right of each Employee to negotiate concerning the rate of compensation in any manner not inconsistent with the foregoing contract.

(7.) The right of each Employee to request, in the manner therein indicated, action by the Company on any matter affecting the welfare of the Employee.

(8.) The right of each Employee to have access to the officers of the Company for the statement of any grievance, action on which has been refused or neglected by the Foreman.

(9.) The right of each Employee to belong to any society and to attend any meetings, provided that in so doing none of his agreements with the Company, as herein set forth, are violated.

(10.) The right of each Employee to withdraw, at pleasure, after reasonable notice, from the Company's service.

EMPLOYMENT MEMORANDUM.

_____ *189*

To the PAYMASTER:

_____

The applicant named herein, begins work this day, in Department _____, *as a* _____

He was / *He was not* } *formerly employed by this Company in Dept.* _____

Entered _____ *o'clock.* _____

Foreman.

Check No. _____

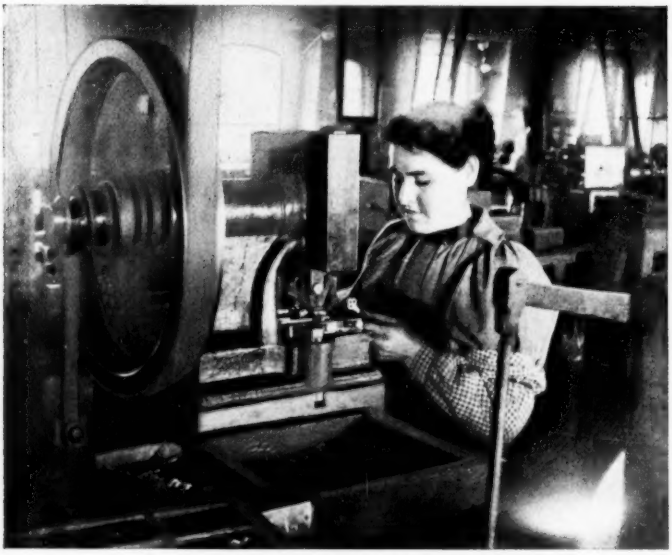
I hereby certify that I know of no reason why the above applicant should not again be employed in the Company's Works.

_____

CUTTING KEYS.

This document is given in full, as its use has secured nearly six years of unvarying amity at the Yale & Towne works. When carefully considered, this paper seems really fair to the workmen in every particular, and, fair or unfair, it has the mint-stamp of successful practice, and hence is worthy of the most respectful consideration.

In 1887 a profit-sharing system was devised to take the place of the contract method. This profit-sharing scheme was based on what the management considered a liberal piece-price for producing the finished work; this was an arbitrary assumption, based, of course, on a long series of records of the previous cost of the same or similar wares, and this piece-price so fixed on work delivered constituted the department's credit. Against this credit the labor cost, files, waste and oil, and small tools' and special tools' maintenance were charged; if the charges footing was less than the credit footing,—as it was, I believe, in all cases,—the difference was credited to the department as profit gained, and one-half was divided among all workers in that department in a flat percentage on wages earned, the company taking the other half. These contracts were made for from three to five years without variation in piece-rates; the foremen were paid at day-



PIERCING THE KEY BOWS.

rates from $4 to $6, and the workmen were paid sometimes day-rates and sometimes piece-rates. The highest gain was as much as thirty per cent. of wages, which gave every man, foreman and workman alike, a 15 per cent. addition to his wages at the end of a year. In case of a foreman who had been a contractor and had made $3,000 a year, and who was, under the profit-sharing system, rated at $5 per day, or, say, $1,500 a year, the 15 per cent. gain would give him $1,725 for his year's pay, instead of, say, $3,000, which he might have made under the contract system. Common hands, making, say $500, would have $75 added, making their total pay $575. The faults of this system are the long periods between divisions of gain, and the small incentive to close application on the part of the foremen. It was abandoned as a general policy in 1893, although profit-sharing was continued in one case up to August, 1895.

The method now in use for reducing cost is to divide the whole force of workmen into small groups, in no case embracing all the occupants of any one room, and, by careful observation of the operations of each group, decide upon possible reductions in piece-prices paid to workmen without lowering their total earnings beyond possible recoupment by the use of improved means of production, or by

increased diligence on the part of the workmen themselves. The foremen are paid by the day, the workmen by the piece. Change is made in the price paid to only a single group at one time; it is the intention to adjust prices once a year; by using the whole year's time, and hence affecting very few workers at once, this method of reducing piece-prices is followed without difficulty. It probably could not be followed without a new force of hands each year, if the reductions were made on the same day throughout the entire establishment.

About one hundred girls are employed, whose pay runs from 75 cents to $1.25 per day. The pay of moulders and tool-makers is from $2.25 to $3.00 per day, the moulders on piece-work; lock-makers, $1.50 to $2.00; boys, from 75 cents up. Just now (October, 1896) the establishment is short-handed and on short time, though it has been generally the case that hands who wished to do so could put in three thousand hours of work in a year.

The marked features of the Yale & Towne management to-day are extreme neatness of premises, great attention to really artistic designs of ornament, lavish tool-making in every department, and, last and

SETTING UP THE YALE LOCK.

most important and individualizing of all, the perpetual and everywhere present personal influence of the presiding officer.

WORKSHOP LAVATORY.

Mr. Towne is conscious of the rectitude of his intentions, and intends in all cases fully and fairly to consider the best interests of all parties affected by any proposed course of action connected with the shop management; he believes that, if the situation is clearly and minutely explained to the workmen, they will in all cases approve his decisions, and the management will consequently have the hearty coöperation of the hands in carrying proposed changes to a successful issue. Hence a constant succession of notices and bulletins posted through the shops, of which two are given as sufficient examples, although others, even more unusual in form, were in evidence.

NOTICE

To Superintendents & Foremen.

Subject: Disposition of Scrap Metal.

In order to obtain better prices for our scrap, it is necessary that, as far as possible, all steel and iron scrap shall be kept separated one from the other, and turnings not mixed with scrap consisting of solid material.

To reduce general expenses of handling scrap, arrangements have been made by which two of the yard-men will pass through the different departments every other day and collect all scrap therein, transporting it to places provided for it. This only applies to miscellaneous small steel and iron scrap. Departments P and T will dispose of the main body of their scrap, as heretofore. This refers particularly to skeleton steel and brass scrap produced by P, and the iron and steel turnings produced by D and T. In these cases the above-mentioned departments will have their scrap wheeled to places designated.

We trust that with the coöperation of the superintendents and

foremen of the different departments and rooms, we may reduce the expense of handling this material to the lowest limit.

THE YALE & TOWNE MFG. COMPANY.

February 25, 1896.

NOTICE

To Superintendents & Foremen.

The expense account for electric light, gas, and water for the year 1895 has been greatly in excess of the expenditures for previous years.

As this amount represents about one-sixth of the total running expenses for heat, light, and power, it is quite necessary that it should be reduced to a minimum. You are requested, therefore, to use extraordinary care and diligence in the use of gas, electric light, and water in your respective departments and rooms therein. Especial attention should be given to the use of lights Saturday nights between the hours of 5 and 6. Persons delegated to clean machinery should be cautioned to put out all lights not actually needed. In cases where there is running-water in the rooms, either for cleaning, plating, or manufacturing purposes, extra care should be exercised in the quantity used, and pains should be taken to see that the faucets are closed when the water is not actually needed.

By exercising due care in following the above suggestions, the departments will not only coöperate in the reduction of running expenses to the company, but also reduce the amount chargeable to their respective departments.

THE YALE & TOWNE MFG. COMPANY,
F. A. Waldron,
Supt. Power and Plant.

Dated, Feb. 21, 1896.

The Yale & Towne Company owns no tenement property. Deposits may be made by the hands with the company at four per cent. interest, compounded annually.

The workmen have a mutual benefit association, managed exclusively by officers of their own choice. Full members pay monthly dues of 50 cents, and may draw $5 per week for twenty-six weeks in any one year, if prevented from work by sickness; $100 is paid in case of death. Medical advice is furnished free, and a twenty per cent. rebate on prescriptions is given. Junior dues and benefits are half the above. Monthly dues are remitted when there is $1,800 in the treasury; the average is about ten monthly payments in the year. This association also gives one day's summer outing to its members, and one winter evening assembly.

There was a very elaborate scheme in practice for a time for encouraging the workmen to make inventions and improvements in shop-processes. The last payments under this scheme were made some two years since, and this unique plan may be considered as among the things of the past, not needing to be specifically detailed here.

It will be observed that the dominant feature in the prevailing system of labor employment in the shops of the Yale & Towne Manufacturing Company is individual piecework, wherever applicable, in other words, the employment of self-interest as the chief and best stimulant to keener intelligence and greater exertion in the performance of work. In all cases piece-rates are so adjusted as to enable competent workmen to make earnings at least equal to, and usually better than, their earnings when working by the day. Moreover, piece-rates, when once established, are maintained without change for a period of at least twelve months, this fact being announced in advance and employees encouraged to make as high earnings as possible during the period. When facts appear to justify it, piece-rates are reduced, but never below the point at which a competent workman can make more than his day-rate. The fairness of this system is obvious, and during the many years since its adoption no difficulties have arisen as to piece-rates between the company and its employees.

Perhaps, however, the most striking characteristic of the management is its centralized character,—the well-defined relationship of each subordinate to the next in authority, and the final centering of all of these under a single executive head. This system has been so perfected as to enable the president, by means of regular and frequent reports, both written and oral, from the various heads of departments, to keep in close touch and sympathy with all, to co-ordinate and harmonize the operations at every point, and to exercise an effective direction of operations in every department.

HIGH-SPEED STANDARDS OF MEN, MACHINERY, AND TRACK.

By H. G. Prout.

SPEED, being first a question of power, must affect the size and weight of the engine. In turn the weight of the engine and the speed at which it is driven affect track and bridges. But speed depends upon ability to keep going after you start, and this is largely a matter of signals and all the machinery of protection. Furthermore, speed from terminus to terminus is a question of economy of the seconds consumed in stopping, and this concerns the efficiency of the staff,—in other words, administration and discipline.

As locomotive wheel-weights set a limit below which permanent way cannot go, we may begin our consideration of the relations of high speed to men and material by inquiring somewhat into changes that have been made in recent times in the weights carried on locomotive drivers.

In 1880 the highest type of fast passenger locomotive on the Pennsylvania Railroad was the class K engine, which carried 59,000 pounds on four drivers, or 14,750 pounds on each driver. The drivers were 78 inches in diameter and the cylinders 18 × 24 inches. The boiler was 49½ inches in diameter. This engine had developed in 1894 into the revised class P, carrying 21,800 pounds on each driver, the drivers being 80 inches in diameter. The cylinders were 19 × 24 inches, and the boiler 57⅞ inches. To-day the class L is the highest standard of the Pennsylvania. This engine has 22,900 pounds on each driver. The cylinders are 18½ × 26 inches and the diameter of the drivers 80 inches.

On the New York Central Mr. Buchanan had brought out in 1877 his standard 8-wheeler. These engines carried 44,800 pounds on the drivers, or 11,200 pounds on each. The cylinders were 17 × 24 inches, the drivers 68½ inches in diameter, and the boiler 47¼. About 1892 the 800 class was brought out, of which the well-known No. 870 was the pioneer. This locomotive has cylinders 19 × 24 inches, and carries 81,400 pounds on the drivers, or 20,350 pounds on each. The drivers are 78 inches in diameter and the boiler 58 inches. A little modification brought out a year later the New York Central's class N, of which No. 999 is the most famous individual. The drivers of this class are 86 inches, and they carry 21,000 pounds on each. All of these later locomotives, the Pennsylvania class L, and the New York

Central 800 class and class N, are running in regular service, and are no longer looked upon as exceptions.

But such dimensions and wheel-weights are not confined to these two roads. Within the last two or three years there have appeared, among other big locomotives designed for fast passenger work, the Delaware & Hudson Company's 19 × 24-inch engines, with 68½-inch drivers carrying 21,000 pounds on each driver; the Chicago & North Western's recent 8-wheelers with 19 × 24-inch cylinders and 75-inch drivers carrying 19,500 pounds on each driver; the Lehigh Valley's wide-firebox 8-wheelers with 19 × 26-inch cylinders, 76-inch drivers, and 81,800 pounds on the drivers, or 20,450 pounds on each; the Chicago, Burlington & Quincy's Columbia type with 19 × 26-inch cylinders, 84¼-inch drivers, and 21,550 pounds on each driver; the New York, New Haven & Hartford's latest 8-wheeler with 20 × 24-inch cylinders, 73-inch drivers, and 23,000 pounds on each driver; the Rock Island's class 22-A with 78-inch drivers carrying 20,750 pounds on each, and 19½ × 26-inch cylinders. It must not be understood that I have attempted to mention all of the heaviest recent passenger engines,—only enough examples to show the weight now concentrated on a driver.

All of these engines have four-coupled drivers. These do not, however, express the maximum wheel-weights now in use. The Philadelphia & Reading has in service two recent locomotives lighter than the 8-wheelers which we have mentioned, but carrying more on the drivers. These are single-driver engines,—that is, with one pair of drivers. The driving wheels are 84½ inches in diameter, and each one carries 24,000 pounds. The cylinders (compound) are 13 and 22 × 26 inches. It is not at all improbable that this type will come into larger use in this country as the conditions under which it is most efficient are developed,—that is, as the demand grows for a class of rather light but very fast trains not making many stops. It is supposable that such conditions will be developed in this country with increase of population, as they exist to-day in England.

Simultaneously with this development of the locomotive has gone on an improvement of track. It would be absurd to claim that this has been the consequence solely, or even chiefly, of the increase in speed of trains. The greater part of the revenues of the railroads of the United States comes from freight traffic. Out of the total traffic earnings of $1,075,000,000 in 1895 the earnings from freight were $730,000,000, or 68 per cent. of the total. The freight train-miles run in the year were 38 per cent. more than the passenger train-miles. The weight of freight trains, and consequently the weight of freight locomotives, has increased even more than the weights in the passenger service. What

part of the cost of maintenance of way is due to freight and what should be assigned to passenger traffic no one can possibly determine. The interstate commerce commission has at last abandoned the attempt, persisted in for a number of years, to distribute maintenance of way expenses between freight and passenger business. The chief object in increasing the weight of rails and in making track more stable is to save maintenance expenses.

It follows that heavier freight locomotives, heavier and faster freight trains, and increased freight-train mileage must all have had much to do with improvement in the track in the last ten or twenty years. Still the growth in passenger-train speeds has had a great influence in bringing about the improvements designed, not only to decrease maintenance expenses, but to add to the safety of working fast traffic.

One of the first improvements to be observed, and the only one for which we can really give figures, is in the weight of rail. I have tried to get some measure of this increase, and to that end have consulted rail makers.

The Lackawanna Iron & Steel Co., in 1891, rolled no rails over 80 pounds to the yard. In 1895 nearly 21 per cent. of their product was from 85 to 100 pounds per yard and nearly 12 per cent. was 100 pounds. In 1891, 28 per cent. was 80 pounds and in 1895, 30 per cent. was of that weight; 50¾ per cent. was from 72 to 80 pounds in 1891, and in 1895 those weights made up 52.7 per cent. of the total product. In 1891, 17.24 per cent. of the product of these mills was 56 and 60-pound rails; in 1895 these weights were but 1.69 per cent. of the total. The heaviest rails rolled by the Bethlehem Iron Co., in 1874 were 65 pounds to the yard; in 1884 their heaviest rail was 76 pounds; in 1893 it was 100 pounds. The *average* weight of rails rolled by the Illinois Steel Co. in 1889 was 63.5 pounds per yard; in 1895 it was 71.08. This average rose steadily year by year in that period of seven years. The Pennsylvania Steel Co. reports that 56-pound rails seem to have been discarded by railroads in the east from main line standards, and that roads of heavy traffic are going up to 85, 90, and 100 pounds, the recent tendency being to 100 pounds. These reports show the rate of the movement towards heavier rails with considerable accuracy.

If we take up individual roads, we see the same tendency. The New York Central, for example, adopted 80 pounds in 1883, increasing the weight at one step by 15 pounds. Recently that road has put in considerable rail as heavy as 100 pounds to the yard. The Pennsylvania Railroad adopted an 85-pound rail in 1888, and now it has gone up to 100 pounds as standard for main line of heaviest traffic. In 1889 the Michigan Cenral adopted an 80-pound rail as standard, and in 1888

the Philadelphia & Reading put down a 90-pound rail on its line of heavy fast traffic between Bound Brook and Philadelphia. In 1890 a 95-pound rail was designed for the Boston & Albany, and that is now the standard weight of that road. I have mentioned the pioneers, but do not pretend to have named all the railroads that have adopted standards of 80 pounds or more.

It seems worth while to mention one exceptional case. The Manhattan Elevated in New York uses very light engines, and its maximum speeds are not high; but it is one of the very few railroads in the United States that have a 90-pound rail. Here the intensity of the traffic and the difficulty and cost of renewing rails introduce special conditions.

The improvements in recent years in ballast, in drainage, in ties, and in all the elements that go to make up permanent way cannot be measured by any figures, even approximately correct. We can only say "from information and belief" that they are no less striking than the growth in the weight of rail. Perhaps the increase in weight of railroad bridges, made necessary by the greater weight of recent locomotives, is even more important than the increase in stability of permanent way. In short-span bridges especially the change in practice in the last ten years has been very remarkable. Plate girders have taken the place of pony trusses; trussed spans have been made heavier; and solid, ballasted floors now find many advocates among bridge engineers.

But, when we are considering the past experience and the future effects of very high speeds on material and methods, we must not forget the question of stopping. This is perhaps the most important of all, and certainly one of the most difficult to deal with. That you may stop in time two things are necessary,—the machinery that tells you to stop and the machinery to stop with—signals and brakes. Perhaps few people have any conception of the speeds that are reached in daily practice. All over the country trains are run at over 60 miles an hour every day, and must do that to make their time between terminals. There are trains that get up to a speed of 75 miles an hour for short distances in their regular daily runs, and 80 or 85 miles is not an infrequent speed for an occasional mile or two. There are engines now running that have made over 90 miles an hour, hauling regular trains.

These figures are very pretty to read, and we may justly regard them as among the glorious achievements of our century. But what will happen when we are called upon to stop from such speeds? With good conditions, with an express train fitted with air brakes up to the best standard practice, with a dry rail and a level track, we may expect to stop an ordinary passenger train within about 1,200 feet from

a speed of 60 miles an hour. Under such conditions, however, if we attempt to stop from a speed of 90 miles an hour, we shall find that at the end of the sixteenth second after making the application of the brake we are still running at 61 miles an hour, and we shall have run about 1800 feet in those 16 seconds.* We may then hope that our train will stop about 1200 feet further on, making the total distance run, from the time the signal to stop was acted on, 3,000 feet. This, be it observed, is when all conditions are favorable. Let the reader pause a moment and try to imagine how he would feel if he were in the cab of a locomotive running 90 miles an hour and saw the track ahead fouled by a wreck on the track alongside. Let us hope that he would keep cool and do his duty; still, he would have a poor chance of getting out of the scrape alive.

The problem of designing a brake apparatus that shall be simple enough for ordinary working and that shall permit the application of much higher pressures than are now used at the beginning of a stop, and the gradual reduction of the pressures as the speed goes down, is one to which Mr. Westinghouse has given a good deal of attention. Such a "reinforced" brake is now in use on some of the fastest trains that are run; but I fear that humanity can not hope soon to be able, in regular railroad working, to annihilate the energy of 90 miles an hour, or even of 75 miles an hour, in the time and space that now serve to stop from 50 miles an hour. If people will run trains at over 50 miles an hour, they can hope for reasonable safety only from a complete system of signaling, laid out and worked with reference to the highest speeds run; and for very high speeds this signaling must provide for giving warning at much greater distances than are now provided for.

No attempt has been made in a number of years to ascertain what proportion of the mileage of the railroads of the United States is protected by block signals. In England practically all main line on which passenger traffic runs is block-signaled. I should be surprised to learn that as much as 5 per cent. of our own mileage is so protected. It is a singular fact that in the year of the Columbian World's Fair only one of the trunk lines had an unbroken system of block signals from New York to Chicago, and that was the Erie.

The growth in the use of interlocking signals for the protection of crossings, junctions, and all sorts of switches has been great within the last decade, and in this respect the railroads of the east are fairly well protected for usual speeds; but the signals are not often far enough away from the danger points for the high speeds sometimes made.

* See a communication from Mr. George Westinghouse, Jr. in the *Railroad Gazette*, 1892, page 697.

Furthermore, the adequate signaling of a railroad is not merely a matter of safety. For high-speed trains it has another function,—to minimize delays. If very fast time is to be made, it is important that the engineman should never be left in doubt whether or not his way is clear. He must be able to approach fixed signals without relaxing speed,—with confidence that, if he must stop, or get ready to stop, he will get notice in time, whatever his speed. To this end distant signals must be put far enough from the home signals to allow ample time to get "under control" before the home signal is reached, whether the rail is wet or dry, whether the night is clear or foggy, and when the speed is the highest that is ever made in that part of the run. These suggestions are enough to indicate how the signaling of a railroad must be affected by any important increase in the speed of its trains.

But there is a class of stops that cannot be provided for by any system of signaling. On a double-track road a wreck on the west-bound track may foul the east-bound ; a landslide may block the track ; a drunken or careless driver may suddenly appear on a country road-crossing ; a dozen things may happen that signals cannot provide for. When we think of these emergencies and remember how hard it is to stop from very high speeds, we begin to realize the responsibility which a management assumes when it undertakes such speeds, and we suspect that the public has but little conception of its own responsibility in demanding them.

We have considered briefly some of the relations between fast running and the material of railroads ; it remains to see what effect speed has, or is likely to have, on the men.

Sustained journey speed, from end to end of a run, is not merely a matter of high speed between stations ; it involves also making the station stops short. The more stops there are, the more important is promptness at stations. The observant man who travels much cannot fail to notice the effect on trainmen, on stationmen, and even on passengers, of habitual fast running. All hands get trained to alertness and precision of movement. It is a fine thing to watch the handling of a very fast train at a station. It is invigorating to see the speed without haste of the inspectors and the baggagemen, the quick and smooth change of engines, and the cutting off of the dining-car. I have seen the other extreme on a southern railroad, where the easy-going conductor ran past a flag station and then backed down a mile to let off one passenger. His serene indifference to time did not make me feel any safer on his train.

There is great mental and moral value in a training which makes men keen and alert, and breeds the habit of concentrating the facul-

ties, and we may reasonably suppose that this tonic effect of fast trains goes all through the service. We may suppose that the engineman is more attentive to his machine and to the signals; that the signalman and the dispatcher will do their work better, if they have less time to think about other things; that the trainmen, freight and passenger, will take better care of their trains and of outlying switches on a road where the force is keyed up to fast time; that the trackmen will be held to greater efficiency in their daily work and to greater vigilance in patrolling. On the whole, *so far as discipline of the force affects the matter*, we may look for greater and greater efficiency and economy as the result of a considerable increase of speed.

In this hasty survey we have seen that the high speeds of recent years have increased the weights carried on driving wheels, and of course the severity of the blow delivered by the drivers has increased with the speed as well as with the weight. We have seen also that the weight of rails and bridges has been increasing along with the locomotive wheel-weights. We have seen that, if trains are to run more than 60 miles an hour, reasonable safety requires a standard of signaling not yet attained on the railroads of the United States. We have seen, too, something of the effect of speed on railroad men,—a topic that I should have liked to develop at more length had space permitted. In the first article of this series I attempted to show some of the relations between speed and the volume of passenger travel. At the end of the series I realize how inconclusive the inquiry has been. Indeed, the important question of freight-train speed, a matter affecting revenues and cost of working even more than passenger speeds affect them, has been left entirely untouched. But perhaps some lines of inquiry to be followed by other students have been suggested. At any rate this we can safely conclude,—no man will be contented so long as *any* time or space separate him from his interests or his desires. Therefore, the railroad officers can safely act on the belief that the limit of railroad speeds is not yet in sight.

THE COST OF IRON AS RELATED TO INDUSTRIAL ENTERPRISES.

By George H. Hull.

THE steadying effect of an ample visible supply of any staple article of manufacture is apparent, but the importance of this in the case of pig iron is far from being appreciated. In fact there is in the United States no great staple article that is allowed to drift so helplessly in the storms and sunshine of trade as this important product.

It is generally admitted that no manufacturing business can be safely carried on, or made reasonably continuous and profitable, if it depends upon a raw material that is subject to great fluctuations in price. Iron enters more generally into all the great enterprises and improvements of this age than any other staple. It is, therefore, of the first importance that the fluctuations in its price should be confined within reasonable limits; otherwise the business of the whole country must be disturbed, when these excessive fluctuations occur.

To realize how important the price of pig iron is to a long continuance of the prosperous condition of general business, we have only to consider the universality of its use, and to examine the effect its fluctuations have had on the business of this country in the last fifty years.

The history of pig iron in the United States is a succession of periods embracing a quick and enormous advance in price, followed by a quick and enormous decline, resulting in several years of depression and unremunerative prices. These abnormal advances have been caused in every instance by the small surplus stocks carried in the United States, and the struggle of each manufacturer to obtain enough to supply his needs, at each recurrence of a general revival in business.

It was the revival in business and small stocks in 1854 which carried iron from nineteen dollars to fifty dollars. Everything was prosperous, but fifty-dollar iron put a stop to many of the great enterprises; thousands of men were thrown out of employment all over the country; the new furnaces built on high prices came into blast, prices commenced to tumble, and the great panic of 1857 resulted; the price of iron had fallen to twenty-seven dollars,—but it did not stop there; it continued to fall, until it reached eighteen dollars in 1862. The five years of depression ruined furnacemen, right and left, and many of their plants fell into decay.

Stocks were again at a low ebb when the revival of business in 1863 put iron on the up-grade again; there was an actual famine in iron. Prices jumped several times, as much as five dollars per ton in a single day; but even fifty-dollar iron could not stop the prosecution of the war and its attendant necessities, and iron during the following year reached eighty dollars per ton in the middle States and seventy-four dollars per ton in the east.

After the great war-consumption ceased, iron dropped to thirty-five dollars (in 1870), but the increased demand of 1872 put the price up to sixty dollars in the middle States; again the great enterprises were stopped by the high prices, and the panic of 1873 soon followed. Within the first year of the panic it dropped to thirty-five dollars, which was less than actual cost in the middle States, labor and all raw materials entering into its production having advanced so largely in 1872; but it did not stop at thirty-five dollars. It continued to drop, until it reached twenty dollars in 1879, and in these six years it was produced at a constant loss, as the decline in the price of iron always precedes, by a long period, the reduction in the cost of its manufacture. Again, in 1880 the small stock and renewed business carried iron to forty-five dollars.

Will anyone claim that these enormous advances were not important factors in stopping the building of railroads and other large enterprises in each of the periods named, or that the discharge from employment of many thousands of workmen, which this stoppage occasioned, was not the beginning of the panics that followed?

No other great staple is subject to these enormous fluctuations, for the reason that larger stocks of the other staples are carried; but just in proportion as you stop the consumption of pig iron, the consumption of lumber and most other great commodities is checked.

It must, therefore, be admitted that a large accumulation of surplus pig iron in seasons of dullness is the only condition that would prevent these enormous advances in price when prosperous business periods return; but the question is: how can these large surplus stocks be accumulated and carried without injury to the furnace business?

Experience proves that the manufacturers of pig iron rarely carry a combined stock exceeding two or three weeks' production, and that the accumulation of even one additional week's production will carry prices down unreasonably. Manufacturers make their iron to sell; if they cannot get one price, they will usually take a lower. Some of them have money enough to accumulate iron; others have not. The poorer furnaces, which are compelled to sell, lead the decline, and the rich ones must accept the price made by the poor ones.

Experience proves also that consumers of pig iron will not carry

large stocks. Among the few that have surplus money in their business, some addition is made to stocks when prices are going up; but, in the several years that prices are going down, consumers generally buy to supply only their immediate wants, and at no time is their stock so light as at the end of several years of depression.

As a broad principle, then, large surplus stocks of pig iron will not be carried by either the manufacturer or the consumer. It will be done only by some middle element, as is the case with other great staples.

In the case of general articles of trade, like dry-goods and groceries, it is done by the jobber and retailer; this we will designate as "natural carriage." In the case of large staples, like cotton, grain, petroleum, provisions, and pig iron, it can be done only by storing the article itself, issuing a negotiable certificate against it, and bringing about general dealing in these certificates on exchanges; this we will designate as "certificate carriage," or "warrant system."

Every great staple except pig iron has had this "certificate carriage" established for it in this country. In the case of each of these staples the majority of the producers at the start have been unfavorable to the introduction of that particular commodity on exchanges. They reason that, if the small "natural carriage" of surplus stocks depressed prices, a large "certificate carriage" would depress prices more violently still. They reasoned, too, that the fluctuation in that article would be increased by its introduction to exchanges.

A careful examination into the history of every staple article that has been introduced by certificates to exchange dealings proves that both of these theories are unfounded. On the other hand, an exhaustive examination shows that the extreme fluctuations have ceased, in the case of each of the staple articles, after the introduction of that article to exchange dealings. We will give but one illustration.

Petroleum, before it was introduced on exchanges, showed violent fluctuations for nine years, ranging from fifty-two cents to seven dollars and eighty-eight cents per barrel at the well. A surplus stock of a half million barrels carried the price down to fifty-two cents. The extreme fluctuation for nine years after it was introduced to exchanges was from sixty-four cents to one dollar and six cents, and a surplus stock of thirty-six million barrels carried the price down only to sixty-four cents. Every great staple that has been introduced to exchange dealings in this country has experienced like results, the producers of these articles, as well as the consumers, realizing a steadying effect not experienced before.

Just in proportion as pig iron enters into the general business of this country will the general business of the country be benefited by

the introduction of a system that would curtail the violent fluctuations in its price.

It is believed by some that this "warrant system" will not absorb large stocks of pig iron, and they cite the fact that even moderate lots of ten thousand or twenty thousand tons of speculative pig iron, such as have been carried during various time in the last twenty years, have always depressed the price; but they lose sight of the fact that these speculative lots have been carried by unnegotiable storage receipts, and such carriage has always been, and always will be, harmful to the iron trade. There is, however, between this carriage and the carriage by a negotiable certificate dealt in on exchanges the widest difference.

This "warrant system" has existed in Scotland for over fifty years, and for thirty years out of this time surplus stocks of pig iron in Scotland had been equal to from six to twelve months' production. During one period the stock for five years in succession exceeded a year's production.

What better assurance can there be of the benefit of this system than its fifty years' history in Scotland? That market has not been subject to the violent fluctuations which have occurred in the United States, and the manufacture of iron in that country has been more uniformly profitable.

Many believe that the investing and speculative public will not absorb a large stock of pig iron through exchange dealings, but there is no real foundation for this doubt. The public will not carry unnegotiable storage receipts, just as the public would not carry petroleum stocks until they were put in proper shape; but, as soon as these stocks were represented by exchange certificates, the public quickly absorbed thirty-six million barrels, and carried it without any depressing effect, and that same public will carry all the surplus pig iron that can be accumulated in this country under the "warrant system."

More than one-fifth of the entire wealth of the United States today is invested in the carriage of property represented by certificates. The addition of stocks, bonds, and certificates on the New York Stock Exchange alone averages about four hundred millions per annum. It is really the only shape into which property is put in which the money may be said to seek the property. There is no reason to doubt that this class of money-owners will absorb all the surplus iron that is represented by negotiable exchange certificates. They have absorbed like certificates for all the surplus cotton, grain, petroleum, provisions, etc. The actual expense of carriage to the investor, on pig iron, is about one fourth what it is on all these other great staples. It is this feature that has tended largely to make pig-iron warrants the favorite speculative commodity in Great Britain for many years.

We have had no such violent fluctuations in price of iron during the last ten years as we had during the thirty years previous, for the reason that we have had no such violent and long-continued panics, and the cost of iron is permanently lower; but the moderate revival in business in 1889 and 1895 caused an advance of seventy-five per cent. to eighty per cent., and these ruinous fluctuations will continue until large surplus stocks are carried.

This "warrant carriage" not only is a benefit to the trade during seasons of business activity, but is of equal benefit in another way during seasons of depression,—by absorbing the surplus as it is made, thus enabling the furnaces to continue in blast, without overloading and depressing the consumers' market, whereas, without this system, the furnaces go out of blast in about the proportion that the consumers cease to buy. We have had an illustration of this during the last few months.

In the Shenango and Mahoning valley, where the "warrant system" had not been adopted, there were, in January, 22 furnaces in blast, 19 of which had gone out of blast by August 15. In the Alabama and Tennessee district, where the "warrant system" had been adopted by most of the furnace companies, there were, in January, 32 furnaces in blast, only 7 of which had gone out of blast by August 15. In fact, every furnace company in the southern district which had adopted the system was not only able to keep its furnaces in blast at the time of greatest depression, but was able to sell, through exchange warrants, all its surplus stock at satisfactory prices.

An effort to force off ten thousand tons in the first-named district during the depression in August resulted in only a small sale, at one dollar and fifty cents per ton below quotations, whereas, in the southern district, where the system had been adopted, fifty thousand tons were easily sold by warrant, at the same time, on a concession of ten cents per ton, followed by a sale of another fifty thousand tons at a substantial advance.

The conditions in these two districts were very different, but this does not affect the point we wish to illustrate,—namely, that the previous introduction of the "warrant system" in the south had created a trade for southern warrants which quickly absorbed all the surplus iron as soon as the demand from the consumers ceased, a condition wholly lacking in the valley district.

A prominent iron master of Great Britain recently said, in reply to a question as to the usefulness of the "warrant system" to producers and consumers in Great Britain:

"They simply could not get along without it. It is a necessary adjunct to the iron business. Consumers and dealers who desired to

make prices on large lots of manufactured iron and steel for long future delivery would be obliged to take a large risk of the market, if it was not for the 'warrant system.' As it is, they can always protect themselves on these bids by purchases of warrants. Then from the producer's point. Furnace companies having on their yards a large stock of iron, or a large stock of raw material, if they anticipate a decline in the market, can telegraph to Glasgow and sell ten thousand to twenty thousand tons by warrants within a few minutes, without affecting the price more than one or two pennies, whereas, if they attempted to sell a like amount of iron to consumers, they might be a week in doing it, and would depress the consumers' market as many shillings, as they would pence by selling on the warrant market."

The general adoption of exchange dealings in pig iron would enable the producers to market all their surplus product in times of depression, without undue lowering of prices.

The accumulation of large surplus stocks through this means would not prevent a reasonable advance in prices in seasons of large demand, but would prevent the enormous advances which quickly hamper and eventually paralyze great enterprises.

"Stability of value is the safeguard of the producer and consumer alike."

RAILROAD BUILDING AND MANGANESE MINING IN COLOMBIA.

By Eduardo J. Chibas.

AS the United States become more and more settled and developed, and as industries of all classes and the various means of transportation by land and water rapidly multiply, the fields for the investment of capital with expectations of obtaining a high rate of remuneration become narrower, and the natural desire to obtain a larger return has turned the eyes of capitalists to the vast and yet undeveloped countries of Spanish America, whose wonderful natural resources are still hidden in the heart of its mountains or in the thickness of its almost impenetrable forests, simply awaiting the activity, energy, and industry of men to give them a commercial value in the markets of the world.

The object of the present article is to describe the work carried on by an American corporation—the Caribbean Manganese Company, of Baltimore, Md.—in the Department of Panama, Republic of Colombia, to develop the manganese mines of that region.

Before entering, however, into the subject-matter, it is pertinent to say a few words as to the nature of the surroundings and the peculiar conditions under which the company had to labor. The country lying between Nombre de Dios and the mines was covered by a tropical wilderness, some portions of which had never been penetrated by man. Both terminals of the railroad were located at a considerable distance from the established lines of communication with the outside world, making it difficult to obtain supplies and material with which to start operations; and the port of Nombre de Dios, about forty miles northeast of Colon, was entirely unknown to the commercial world, although it had been visited and named by Columbus on his fourth voyage, in 1502. Tradition has it that, while sailing along that coast, he was driven by a storm into this port, and he was so thankful for having escaped the tempest that he exclaimed when he landed: "En nombre de Dios fundaremos aqui un pueblo," meaning: "In God's name we shall here build a settlement." His wishes were fulfilled eight years later by Diego de Nicuesa, who founded on the same spot the town of "Nombre de Dios." This settlement increased in population and prospered till it was partly destroyed by the Indians in 1584, when, by a royal decree issued by Philip II, king of Spain, the place was abandoned, and the town transferred to Portobelo, twenty miles to the westward. At present

THE MAIN STREET OF VIENTO FRIO.

only a few remnants of brick and stone foundations mark the site of old Nombre de Dios, about a mile and a half from the present headquarters built by the Caribbean Manganese Company.

During all the preliminary surveys and a large portion of the period of construction the company made its headquarters in Viento Frio, a native village on the coast, five miles east of Nombre de Dios. The nearest post office, or place to obtain supplies, was Colon. All communication between this latter place and Viento Frio had to be made by sea, as tropical jungles and swamps barred the way by land.

LOCATING THE LAST MILE OF THE RAILROAD.

CLEARING THE LINE OF THE RAILROAD.

There being no steamboats in that portion of the country, it was necessary to rely entirely on sloops for our coast service. One of these, with the suggestive name of "The Hard Times," was bought by the company in Colon, and for a long while furnished the only means of communication with the outside world.

Her extreme length was twenty-five feet. She was completely decked over and provided with two hatchways,—one giving access to the hold, the other to the cabin towards the stern. With fair wind the trip could be made in six or seven hours, but with head wind and adverse current, or during the season of calm, it took two or three days. On one occasion, in going from Viento Frio to Colon, the writer was caught in a spell of prolonged calm, and, after having been out four days and three nights, had been able to cover only half the distance. At the end of that time it was decided to leave the "Hard Times," and make the remainder of the journey in a canoe, or native dug-out, paddled by two Indians. A landing was made in Colon twelve hours later, at the end of four days of traveling, in which only forty-five miles had been covered. During the winter, or dry season, the sea in that portion of the coast is very rough, and the journey becomes a somewhat perilous undertaking. The writer has a very vivid recollection of his first trip on the "Hard Times," which was made at that period of the year. We left Colon before sunset with a light wind that kept gathering strength till midnight, when we were threatened with a severe squall. By this time clouds had gathered overhead, and blackness so completely surrounded us that it was im-

possible to see the entrance of the small port towards which we were steering for shelter, save when the lightning showed us the way. Finally we succeeded in anchoring in a safe place, and, after taking in the sails, we spread a canvas awning over the deck to protect us from the rain, that shortly afterwards poured down. The protection, however, was only partial, as the drippings from the canvas and the rain that blew through the sides had drenched us to the skin long before morning. After encountering a few more squalls, but less severe, we arrived in Viento Frio on the morning of the third day. This village is inhabited by a few hundred natives, living in a very primitive fashion. Their dwellings have thatched roofs made out of palm leaves and sides of wild cane, or of native board formed by splitting and flattening out the palm tree. The peculiarity of these native huts is that not a single nail enters into their construction, all the frame work being tied together with vines.

Owing to the difficulty of transporting building material from Colon, and for the sake of economy, all the dwellings put up by the company during the period of construction were similar to the native huts, though they had a pine flooring. The thatched roof is the coolest covering for that climate, but has two serious inconveniences: it is apt to catch fire very easily, and is an attractive place for small snakes and various insects.

The first work in connection with the railroad was the reconnaissance, or exploration of the country between the coast and the mines, in order to determine in a general way through what portions of the country it would be advisable to make the surveys. The only instru-

A CUT ON THE VIENTO FRIO BRANCH.

CUT AND FILL AFTER PASSING LA GUACA.

ments used were a pocket-compass and an aneroid, the former to get general directions, and the latter to determine approximately the heights of the hills to be crossed. After this was completed, the preliminary surveys were started. This work, like the previous one, proves to be a very laborious undertaking in those countries, as the first difficulty that confronts the engineer is a thick tropical jungle, where, at times, he cannot see fifty feet ahead of him, and the absence of roads or even footpaths makes it impossible to move without cutting one's way with the native machete. The surveying party stayed

WORK-TRAIN AT THE BALLAST PIT.

COMPANY HEADQUARTERS, NEAR NISPERO MINES.

in camps built along the road, about three miles apart. These camps were temporary affairs, put up by half-a-dozen natives in one day, and consisted of posts supporting a palm roof. They had no sides, and were just large enough to accommodate the party. It being impossible to use pack-mules to carry the camping-outfit, that work had to be done by men. Some of the natives, especially in the interior, possess great power of endurance; they will walk up and down mountains with a weight of two-hundred pounds strapped to their shoulders, with apparent ease. Strange as it may seem, they

THE BALLAST GANG.

live almost wholly on a vegetable diet, making use of meat only at long intervals. The rainy season set in before the surveys of the mountainous portion were finished, and for several days it was necessary to work in showers that occurred at short intervals. The only means of drying clothes was by the evening camp-fire, when the stillness of the night would be broken, now and then, by the night-cry of some wild animal in the adjacent forest.

After the preliminary surveys had been completed and the writer's report had been accepted the final location for the railroad was made, as well as all the plans and estimates for the entire work, and clearing of the line was started. To be able to appreciate the nature of the battle against such an exuberant growth, it is necessary to have actually grappled with the problem. Some of the illustrations will

A PARASITE, LOCALLY KNOWN AS THE TREE-KILLER.

give a better idea of the grandeur of the vegetation than it is possible to give in words. One of them shows a parasite locally known as "matapalo," meaning tree-killer, because, when it begins to grow, it winds itself around the large trees and continues growing until it assumes such proportions that the parent tree succumbs in its grasp and begins to decay. To give an idea of the rapidity with which vegetation grows in that climate, combining extreme moisture and high temperature, it may be stated that, after the clearing of the line had been completed, the work was suspended for seven months, and, when it was resumed, the bushes had attained a height varying from five to seven feet. As soon as this new growth had been cleared away (in January, 1894), the active work of construction was begun, start-

A SLIDE IN A CUT, DUE TO HEAVY RAINS.

ing with the excavations. The total amount of material removed from cuts or thrown into embankments was 94,670 cubic yards. The sides of the clay and earth cuts were left at a steeper inclination than the customary 1 to 1 slope, and, with few exceptions, they stood well. This greater stability in the tropics, in spite of the heavy rains, is probably due to the absence of frost, which is one of the principal agents of disintegration in colder climates.

The unloading of the material gave considerable trouble, as, on account of certain legal difficulties, it was necessary to build the road

SIDE-HILL CUT NEAR BELLA VISTA.

BUILDING A TRESTLE.

first from Viento Frio to the mines, and not until this portion had been almost completed could the line be extended to Nombre de Dios.

The schooner that brought the material could not anchor in front of Viento Frio, on account of the heavy sea prevailing at the time ; so she had to proceed to Nombre de Dios, where the cargo was transferred to lighters, which were towed to Viento Frio by an old and small wooden steam-tug that had been secured for temporary use. Before half the cargo had been taken out, however, the tug was wrecked. This made it necessary to transfer the rest of the cargo to

CONSTRUCTION OF BRIDGE NO. '38.

THE FIRST CLEARING AT NISPERO MINES.

the beach at Nombre de Dios, and the lighters were moved back and forth by pulling on a rope stretched from a tree on shore to the stern of the schooner, anchored about 1,500 feet away. After this operation had been completed, more than half the cargo, made up of rails and lumber, lay piled on the beach. To transport it by land was out of the question, and there were no sloops along the coast willing to handle such a cargo. Finally all the lumber was transported in rafts towed by natives in their canoes, and the rails on one of the thirty-ton flat bottom lighters temporarily rigged up with a mast and sail. As this

A MANGANESE BOULDER ON TOP OF NISPERO MOUNTAIN.

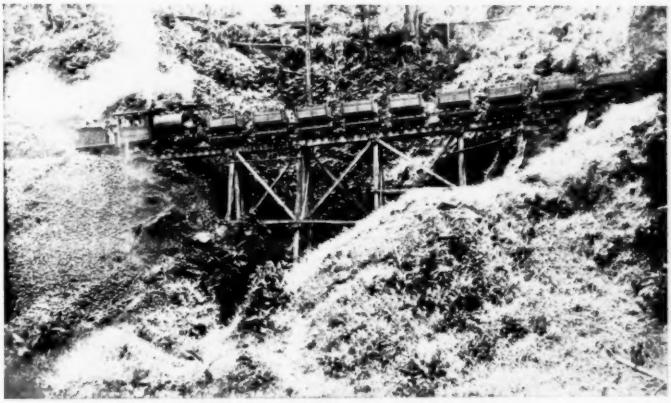
CHUTE BETWEEN FIRST AND SECOND LEVELS OF THE ORE-TRACK.

lighter had not been built for sailing purposes, she required careful handling, and had to be helped at times with oars, and very often by warping,—a process that consisted in hauling on a rope fastened to an anchor previously dropped by a row-boat about five hundred feet away from the lighter and in the direction in which it was desired to move her. In this manner, and after delays caused by heavy seas, the whole cargo was got safely to Viento Frio. When enough material was on hand, track-laying was started. Shortly afterwards the locomotive was put on the track and used to haul carloads of ties,

CHUTE BETWEEN TWO DIFFERENT LEVELS AT MINES.

rails, and bridge-lumber to the end of the track already laid. It was also used to distribute along the line ballast taken from three different cuts containing appropriate material, so that the road-gang, tamping and lining the track, could follow the track-laying gang as closely as possible. The track is composed of thirty-five-pound rails spiked to ties six feet long and distributed at the rate of about 2,200 ties to the mile. The gage is three feet.

In the nine miles traversed by the railroad a great variety of natural difficulties were met,—from the shallow lagoons and swampy ground that covered portions of the first three miles to the broken and mountainous country that characterized the latter portion of the line, where it was necessary to adopt a maximum grade of five per



A TRAIN OF ORE GOING DOWN THE 5% GRADE.

cent., in favor of traffic, and maximum curves of 40°, 146 feet radius, so as to be able to follow along the flanks of the mountain with the least possible excavation. By using the lower limit of curvature usually adopted, the cost of the railroad would have been made so great that the enterprise would have been an impossibility from a financial point of view, but, by a judicious use of sharp curves, the cost was brought within economic limits. The curves constitute more than one-third of the total distance, and, placed in succession in one direction, they would make ten and a third complete circles. There were so many creeks and ravines that it was necessary to build thirty-nine bridges, aggregating nearly half a mile in length and varying in height to thirty feet. The total amount of lumber used was 121,800 feet, board measure, and 374 piles. The latter were of native timber,

A GRAVITY INCLINE, THE LOADED CAR PULLING UP THE EMPTY ONE.

and aggregated 1¼ miles in length. Of the former one-third was of Georgia pine, and two-thirds of native timber.

When the railroad was nearing completion, operations were begun at the mines. The manganese is found on the flanks of a steep mountain. The outcrop near the summit, shown in one of the photographs, is about 500 feet above the Nispero terminal of the railroad and 2,000 feet from it horizontally. For the first few months nearly all workings were on the surface and confined to a belt about a quarter of a mile in length and at a maximum elevation of 200 feet above the

MINING MANGANESE AND TRANSPORTING TO THE RAILROAD.

railroad track. The ore was handled at the mines by means of portable track and one-ton iron side-dumping cars. The tracks were laid along the hill side at different elevations, the vertical distance between them being 25, 50, or more feet, according to the distribution of the ore. They were laid at a light grade of from 1½ to 2 per cent., allowing the loaded cars to go down almost by themselves, and at the same time not requiring much exertion on the part of the men to push up the empty ones. The levels were connected by ore chutes built of planks and rough logs from the neighborhood, and with a minimum inclination of 45°, allowing the ore to roll down easily. At the bottom of this chute there is a gate which, when lifted, lets the ore drop of itself into the car standing below it. The ore was also brought

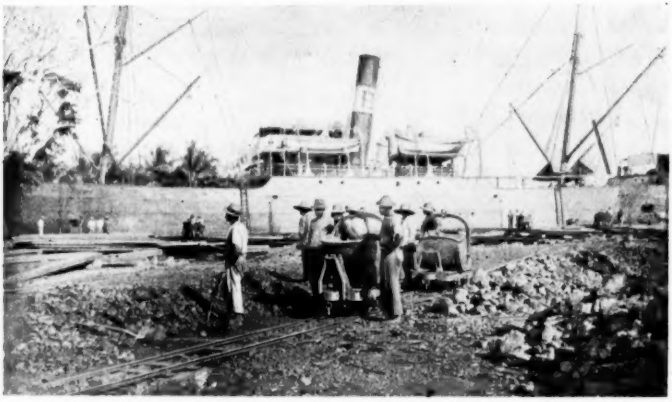
ORE-BINS FROM WHICH RAILROAD CARS ARE LOADED.

down from the highest to the lowest level by an inclined plane, the force of gravity making the loaded cars on their downward journey pull up the empty ones. The mining cars in the lower level emptied into the ore bins, from which four railroad cars could be loaded at the same time in a few minutes, by lowering the gates and allowing the ore to run out.

A word about the harbor work. Nombre de Dios has an outer harbor and an inner one. The latter is an inlet looking more like an artificial than a natural channel. It varies in width from one hundred to two hundred feet, and its navigable length is about eight hundred feet. The steamer, when inside, cannot turn around; it has to come in or go out stern first. This was made easier by anchoring a buoy at the head and another at the terminal of the channel, so that, by fasten-

DRIVING PILES FOR THE WHARF AT NOMBRE DE DIOS.

ing a chain or rope to either, the steamer could haul itself in or out. Iron rings placed on both shores, through which guide ropes could be slipped, served to keep the ship in midchannel. Both shores are lined with coral reefs, and deep water comes close to them. For this reason it was possible to build the wharf, with its length of two hundred feet, parallel to the shore, while its width did not have to exceed fifty feet. The piles for the wharf were shod with iron points, as most of them had to be driven through coral rock. The steamers are loaded by placing the manganese in ore-buckets supported by car-

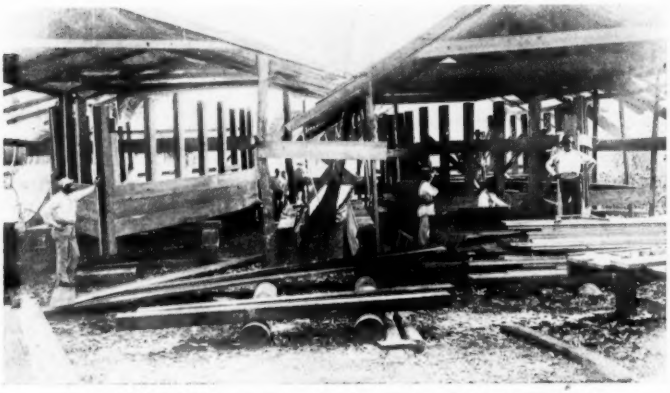


THE STEAMSHIP "EARNWELL" LOADING ORE.

LOADING THE "EARNWELL" FROM LIGHTERS HAULED BY A STATIONARY ENGINE ON SHORE.

trucks that are pushed to the side of the steamer on tracks surrounding the ore-piles and extending to the wharf. These buckets are lifted by the vessel's winches and emptied into the hold. In this manner, by using sixteen buckets it was possible to handle four hundred tons per day of ten hours during the shipment of the first full cargo of ore. The steamers at the wharf can load only from 1,500 to 2,000 tons. To take what they need to complete a full cargo of 2,700 tons or more, they have to move to the outer harbor and anchor about 2,000

ENGINE-HOUSE, CARPENTER-SHOP, OFFICE, AND ORE-DUMPS AT NOMBRE DE DIOS.



OUR VIENTO FRIO SHIP-YARD. TWO LIGHTERS UNDER CONSTRUCTION.

feet from the wharf. One of the illustrations shows the way in which the shipments by lighters were managed without the use of a tug. A hoisting engine stationed near the wharf was used. A rope was passed around the drums, then through a snatch block tied to a tree directly in front, and finally to the stern of the steamer. Thus the lighters were enabled to move back and forth very rapidly.

The arrival of the first steamer to load manganese ore was the crowning event. Therefore the sight, in the early part of May, 1895, of the S. S. Earnwell slowly and majestically moving towards the inner harbor was witnessed with enthusiasm. Nearly a week later, after the cargo had been loaded, and the departing steamer was growing smaller and smaller in the distance, she seemed to be taking away all the hardships and privations of pioneering, and leaving in her wake the beginning of a new era of progress and civilization, marked by all the attending advantages of regular and direct communication with the outside world.*

* Some of the data given in this article are taken from a paper read by the writer before the last annual convention of the American Society of Civil Engineers, on "*The Construction of a Light Mountain Railroad in the Republic of Colombia*," published in Vol. XXXVI of the *Transactions* of the society, and to which the reader is referred for more detailed information.

THE ECONOMY OF THE MODERN ENGINE ROOM.

IV. THE SIGNIFICANCE AND VALUE OF DUTY TESTS FOR ENGINES AND BOILERS.

By E. J. Armstrong.

THE installation of a power-plant presents an exceedingly complicated problem,—one capable of an infinite number of partial solutions, but never so well worked out that further study will not be repaid. The conditions are usually of such a nature as to preclude the attainment of the highest fuel-economy; they are many and various, and are never the same in any two plants. Space may be of much or little value. Preferred types of boilers are often barred by limited height of ceiling. Close engine regulation may be essential or unimportant. Sometimes engines must be capable of making continuous runs of long duration; in other cases a stoppage during the run is inadmissible, and ability to keep going with certainty must be secured, even at the expense of a duplicate plant. The suddenly-applied loads of electric-railway and electric-elevator service introduce features so puzzling that as yet we have not even satisfactory instruments for measuring the power developed, but must go to the electrician's wattmeter. Perhaps an anticipated future demand for greater power must be provided for. The cost and quality of fuel, quality of feed-water, availability of condensing water, cost of repairs, and, to some extent, cost of attendance, vary with the locality, each case having its own set of conditions, which must be carefully studied to obtain the best results. To select the boilers, engines, and other parts of the plant, and lay out the whole so that a satisfactory power-service will be secured, with what in the long run is the lowest cost, is a task calling for the best work of an experienced engineer. It is poor business policy to place it in less competent hands.

An important point which seldom receives the attention due it is the proper proportioning of the engine to the work. The point in its working range at which an engine is most economical varies with its type, its size, and the steam pressure under which it is operated. In non-condensing compound engines of small size and working under moderate pressures the greatest load that can be carried is usually that of best steam economy; in very large condensing engines the lowest point on the duty curve is earlier,—perhaps in some cases as early as one-half of the ultimate load. In simple engines of moderate size it is generally later than two-thirds, and often very near the extreme

load which the engine can carry. In the majority of engines the point of best economy is at a load greater than their rated power. It is, therefore, a mistake to use a larger engine than necessary, for, while the duty may be satisfactory at its most economical load, or at its rated power, the average load to be carried is likely to be much less than this,—perhaps at a point where the engine is extremely wasteful. The special conditions always influence the choice, but it is a good rule to figure what size of engine will be required to carry the largest load anticipated, at the lowest steam pressure to be used, taking (with simple engines) about sixty-five per cent. of this pressure as the M.E.P.

It will pay the purchaser, in receiving bids, if he proposes to see that the contract requirements are met by the engine-builder, to require either complete duty curves, or a guarantee of the duty at a sufficient number of different loads, including the maximum, to enable the curves to be constructed. Superimposing these curves from competing engines will show quite differently from the comparison made with the duty guaranteed at one point only. This may seem, particularly to the engine-builder, to be a useless refinement, but it may easily happen that the engine which will sustain the best guarantee at rated power will make the poorest showing with the varying loads which it is destined to carry in actual service, and the method suggested, if properly carried out, will secure better results than the most expert guesswork. The notoriously loose way in which engine guarantees have been made is largely due to the fact that but few plants are ever tested. No matter what the purchaser may expect to do when he signs the contract, the difficulty and expense of making a duty test after installment are great enough, in the majority of cases, to prevent the purchaser, if the engine be not a large one, from doing anything to prove whether or not the contract requirements have been fulfilled. If everything else is satisfactory, an excess of fuel sufficient to pay the interest on the cost of the engine several times over will seldom prevent a settlement in full. This is manifestly as unfair to the engine-builder who makes no claims he cannot fulfill as it is to the purchaser defrauded. So long as the custom prevails of making guarantees of steam-economy, the fulfillment of which is to be determined by the purchaser after the plant is in operation, so long will salesmen make reckless claims, and collect pay for engines which can never, by any possibility, fulfil the representations of their builders. It would seem that the only proper way to contract for an engine of less than three or four hundred horse power is to throw the burden of proof upon the engine-builder by requiring him to test the engine before shipment. Make him guarantee the duty per brake horse power at several loads

covering the entire range of the engine, and, by actual trial upon his test-floor, demonstrate to the satisfaction of a representative of the purchaser that the contract requirements have been complied with. In the most progressive shops the testing rooms are equipped with surface condensers, by which the steam actually passing through the engine can be condensed and run into tanks to be weighed; and the loads are produced by Prony brakes, or dynamometers, by which a practically constant load can be maintained, and the power delivered by the engine be measured. The difference between this and the power as computed from the indicator diagrams is the friction of the engine, and is also easily ascertained.

The advantages of this system of testing are very obvious, and, should its use become general, as now seems likely, it cannot but have the effect of raising the standard of engine-design. Although seemingly a hardship to the engine-builder, it is really much fairer to him than the attempt to test an engine for steam consumption after it has become a part of the plant. Testing an engine by weighing the water pumped to the boiler is very liable to serious error. It is certain that a part of the feed-water does not pass to the engine. All boilers leak, even when no leakage is visible; and, while they may be, and perhaps usually are, made so well that this loss is small, it would seem only fair to maintain the working pressure in the boilers for some hours, having all outlets closed and noting the amount the water-level falls, or how much is required to maintain it. This leakage should, of course, be deducted from that charged against the engine. Generally it is impracticable to obtain the delivered or brake horse power after installation, and it is usually difficult to maintain a sufficiently constant load for the indicator diagrams to afford a very reliable record of the i. h. p., unless they are taken at much shorter intervals than usual. Frequently, in making duty tests, the feed-pump must be operated from the boilers from which the engine is drawing steam, and it is impossible to estimate with any degree of certainty the amount so used, except by condensing and weighing it, which is usually impracticable. Long pipes, particularly when large for the engine (as they often are, in plants where several engines are piped to one steam main), condense steam, which is difficult to drain from the pipes, and is apt to come over to the engines in installments rather than in a steady flow. When this occurs, the quality of the steam cannot be properly measured by the calorimeter. There is always, if much water be present in the steam, considerable uncertainty in its determination, and still more in making proper allowance for its presence. While the throttling calorimeter seems to be capable of giving accurate indications of the quality of the sample of steam actually passing through it, it is impossible as yet to

obtain a sample which will with any certainty correctly represent the steam passing to the engine. The liability of error seems to increase with the percentage of moisture carried by the steam. It is customary to deduct only the amount of water which the calorimeter readings show to be present in the steam, from the amount passing through the engine. While this water, by its presence in the cylinder, may sometimes cause little loss beyond its own amount, under other conditions it may, seemingly by increasing cylinder condensation, cause a loss several times greater than the actual amount of entrained water, the bad effect is greatest at light loads, and early cut off, becoming very small at the maximum power of the engine. It also seems to be greater at high speeds, and is probably greater in small engines than in large ones. It is, therefore, impossible to make accurate allowance for wet steam. If the piping is short, so that the entrained water comes to the engine in a steady flow, the percentage as measured by the calorimeter, as recent experiments have shown, is likely to be high. It is also probable that the loss by its presence will be greater than the actual amount ; so we have the comforting probability that the two errors are in opposite directions, and tend to offset each other. By the use of a well-designed separator of ample size the moisture may be reduced to a point where the final error is likely to be small. By the elimination of the uncertain factors the engine-builder can promise duties to be demonstrated in his shop which he could not safely guarantee to show after installment in a plant which might, or might not, offer as favorable conditions. To the purchaser an advantage of this method of testing engines is that the delivered or brake horse power can be more readily obtained, and this, rather than the indicated horse power, is what should be guaranteed.

Loss by engine friction is the worst kind of loss, for it is using up power to wear out the engine. It is not easy to understand how long life of an engine and excessive friction can go together. In well-designed high-speed engines of one to two hundred horse power, the friction may be brought as low as four and one-half per cent. This is, of course, a very exceptional figure, but more than twice that should not be tolerated. The friction in horse power will, in such engines, generally be nearly the same at no load as at about two-thirds of the ultimate capacity of the engine, or near the rated power as usually estimated,—being somewhat higher at intermediate loads, and also at loads greater than the rating. With slow-speed engines the friction is generally least when the engine is running light, and it increases all the way up to the maximum load. To assume the friction from the friction-card is not a correct method, and cannot be relied upon to give even an approximate idea of the engine friction under load.

Tests of boilers are necessary to demonstrate both efficiency and capacity, and there is in use a standard method of conducting such tests, and also of making the guarantees. Some years ago the American Society of Mechanical Engineers appointed a committee to formulate a method of conducting boiler trials, which should embody the best practice, and which could be recommended to engineers. The report of this committee was very full, covering the question of guaranteeing and demonstrating boiler efficiencies and capacities, and has since been generally adopted by engineers as the standard method. The report is too long for reprint, even in synopsis; it may be found in Vol. VI, page 267, *Transactions A. S. M. E.*, 1885. After a plant has been completed and put in operation, its original efficiency may easily be impaired in very many ways, and there should be some attempt made to keep track of the coal and water used and the power developed, to form a check upon serious deterioration. Where all the power is used to drive dynamos, the recording wattmeter and the coal bills may give a rough idea as to whether the original efficiency is being maintained, provided records have been kept from the start for comparison. In other cases resort must be had to the indicator to obtain the amount of power developed. In some engine rooms cards are taken at short intervals through a day's run, and the coal used for that day is weighed, this being done several times a year. Partial tests of this kind, while giving only approximate results, are valuable, if made regularly, as forming a check upon losses which might otherwise pass unnoticed; they are about all the tests the average owner is willing to have made. If the plant is large, it is mistaken economy not to provide for keeping daily records of the coal burned and water evaporated. The water should be measured in tanks, not by meter; it is not very expensive to construct two large square tanks, with a long glass tube and a scale fastened to each to show the height of water. These tanks, properly piped to the pumps, will permit the daily water record to be kept with accuracy. The ratio of the coal and water, or the weight of the water divided by that of the coal, will be found to be fairly constant from day to day. If it changes, effort should be made to locate the cause. The boilers can be used as coal calorimeters of the most practical kind, and the relative values of different qualities of fuel ascertained.

If a good fireman raises the ratio, it is worth something to know that he is better than the average, and probably it will be an aid to correct firing to know each day how he came out the day before. There is no progress made except by investigation, and, in the case of a steam plant, without it there is bound to be deterioration. While elaborate and expensive tests are necessary when accurate information

is to be obtained, yet the daily records of coal and water—and occasionally of power—can, in competent hands, be made of much more value in keeping up and improving the plant. If the right man is in charge and given facilities and encouragement, it is truly surprising to see how many chances for improvement can be found, and how many losses detected, not only in the generation, but in the use, of power, which might otherwise have passed unnoticed. With boilers, as with engines, there is a point of maximum efficiency, and, while boiler duty curves are not yet common enough to discuss, yet, in plants where large batteries of boilers are in use, it pays to find out the number of boilers which will do the work with the least coal. Losses occur in the factory which can be detected in the engine room. In many establishments the machinery of transmission uses up the larger part of the power developed; and shafting out of line, or boxes running habitually warm, or perhaps small belts strained up to do double duty, waste coal as truly as a leaky safety-valve. Such things are apt to pass unnoticed, but, if the report comes up from the engine room that the shafting takes ten horse power more to drive than it did a short time before, an investigation is likely to follow.

Perhaps the shafting is fitted with self-oiling boxes, which require filling only once in six months. When the engine is indicated to learn the friction of that shafting near the end of the six months, and again soon after the bearings have been cleaned and refilled, it is probable that the cleaning and refilling will thereafter be done at shorter intervals.

In all establishments where much shafting is being driven it should be one of the duties of the engine-room force to periodically ascertain the power required to drive the machinery of transmission.

EXAMINATION OF CORPORATION ACCOUNTS BY AUDITORS.

By Thomas L. Greene.

THE custom of having a periodical audit of a corporation's accounts by some person unconnected with the management is growing in the United States. It has long been the established practice in England, where auditors are appointed at the annual meeting by the shareholders, and are, to a very large extent, independent of the officers of the company and of the directors. Since, with a return of prosperity, we may expect an increase in the number of corporations formed for transportation, manufacturing, and other industrial and trading purposes which will offer their stocks and bonds for sale, and an increase also in the public interest in all companies, old and new, it is proper that a few words should be said upon the benefits of auditing, and the limits to be placed in the public estimation upon its significance.

For reasons which readily suggest themselves, the American public has, in the past, inclined to put more stress upon the certificate of an examining accountant than the circumstances warrant. A statement of the extreme view about such certificates is found in an article by Mr. J. Selwin Tait in the June number of THE ENGINEERING MAGAZINE, entitled "The Fruits of Fraudulent Railroad Management." Mr. Tait's article is an able, but too severe, review of railroad affairs in the United States. He attributes to downright fraud many investment losses in American bonds and shares which were really occasioned by adverse business circumstances; the fault of the managers in the most of such cases—if fault it should be called—was optimism; the real situation was not faced, and the outcome of bankruptcy considered, but, on the contrary, hopes perhaps not strictly justified were held out to owners of the company's securities. The argument of the management in such instances usually is that, by sustaining the credit of the company, the crisis may be successfully passed; if the company succumbs finally, the security-holders suffer no more because of the efforts to save the property. Notwithstanding a loose impression to the contrary, actual fraud in railroad management is rare.

For both fraud and adverse business conditions Mr. Tait has one principal remedy, and to this remedy, exclusive of many good suggestions made in his article, I shall confine my discussion. That remedy is stated in the following words:

"That auditors shall be elected by the stockholders, and shall have the fullest power to examine the books at all times, and to call upon the president, directors, and officials for whatever explanation or information they may require. That said auditors, who shall be public accountants of unquestioned standing, after examination of balance-sheets, vouchers, books, etc., shall sign and present to the stockholders a statement to the effect that they have examined these carefully, and that the books are properly kept, *and shall exhibit a true and correct view of the company's affairs;* such statement to specify any cause of complaint which has come under their notice." [Italics mine.]

The meaning is plain enough; the investor should rely upon the public accountant, not merely for the verification of the figures on the books, but for a true view of the company's affairs,—that is, for a trustworthy opinion on the values of the company's bonds and shares.

The course of business is comparatively stable in Great Britain; there the changes in the gross and net earnings of the large companies, such as the railways, are slight; but in a new and developing country the fluctuations may be, and often are, great. A statement of profits of an English enterprise, certified as technically correct, may, therefore, be generally accepted as reflecting with fair accuracy the business conditions. But in the United States a judgment passed upon the book-keeping of a corporation is construed to mean much more than in England. Now, it is exactly this extra judgment, really outside the mere figures, which home and foreign investors in American corporations are hoping to obtain; and it is precisely this which was not originally intended to be covered by an ordinary audit of the books. An American railway, particularly west of the Great Lakes, is subject to extreme changes; crop-failure one year and crop-abundance the next may introduce factors whose effect is all important; a war of rates or a shifting of routes may suddenly render worthless the best calculations of the managers; under such conditions an even course of policy is impossible. Take for illustration the question of betterments,—how far they may be charged against income. This question is practically settled in Great Britain, for the comparatively steady course of earnings allows of a fine distinction between expenses and improvements, so that nothing shall be included in working expenditures that can, by any stretch of the rule, be considered as a charge to capital account. Indeed, it is not too much to say that the first duty of the English auditor is to see that every penny of net profit, as technically and strictly defined, shall be paid to the shareholders annually.

But such a construction put upon the accounts of an American railroad would introduce confusion and perhaps financial embarrass-

ment. An American company that paid out all its money in dividends in a prosperous year and devoted little or none of it to works which, according to the English rule, are to be considered improvements and therefore payable by the sale of bonds, would find itself unprotected, and in a bad condition to withstand the "lean" years of business depression. Whether, therefore, all the profits of a company should be paid to shareholders; whether the unused earnings should be set aside for necessary improvements to the plant and equipment, or for the purchase (say) of much-needed terminals; whether these profits could with safety be appropriated in part to such betterments, and in part to an increase in the dividend,—all these are problems to whose solution railroad officers of ability and experience give their best efforts. Is it to be expected that an outside auditor can answer such questions off-hand?

This matter of the charging of the cost of improvements to the proper account is one out of many examples to the same effect which could be given. They all arise from the fact that business and the prospects of business must be fluctuating and changeable in a new country whose resources are not yet fully utilized. It will be clearly seen, therefore, that the auditing of corporation accounts cannot have the same meaning in the United States as in England. The course of trade in Great Britain allows of the application of strict rules to the book-keeping, and the only instruction given to the auditor is to apply these rules, letting the results follow as they may. This fact is recognized abroad by everybody. Books are published, showing how fine is the line dividing the year's profits from last year's losses or from any general expenditure. It is expressly stipulated and supported by the courts that the auditor has nothing to do with the question of the policy pursued by the officers, and this stipulation is carried to great lengths. The auditor is not to question the doings of an old officer or servant of the company, or go behind the returns he may hand in. In a recent case the manager of a company deceived everybody by reporting a false quantity of material on hand, thus increasing profits and assets. The auditor took his word for it, though the simple addition of the year's purchases (less the quantity consumed) to the inventory of the previous year would have disclosed the fraud. The case was carried to the higher court, where the auditor was acquitted on the ground that he was bound to report only upon the books as they stood. This decision follows naturally from the English theory of an audit,—a theory which has, nevertheless, worked well abroad, because business conditions allowed of just such a technical report and were satisfied by it; such an audit does not demand from the auditor any judgment upon the affairs of the corporation or the expression of

any opinion thereon, except as the book-keeping itself may require it.

The moment we step outside these strict rules of auditing, we either hurt its usefulness, or we put upon the auditor the responsibility of deciding upon problems which tax the best minds. Suppose that an audit is to be undertaken upon the books of a railway which has accumulated during the year a large surplus and proposes to spend the whole or greater part of it upon improvements, or has already done so. Manifestly the strict English rule would require the auditor to report that this surplus belonged to the stockholders. If he shrank from such a bold opinion, he must, under the common understanding, either directly or by implication, pass judgment upon the policy of the company by certifying to the correctness of the accounting. Or, to take an opposite case, suppose that a company has felt the pressure of hard times, and, believing that future earnings will make up present losses, postpones repairs to plant, refuses to renew machinery, or omits the usual credit to depreciation and reserve. Should an accountant certify to the correctness of the accounts under such circumstances? If we accept the current meaning of an audit, our supposed accountant is between the horns of a very serious dilemma; for what the public (led by the success of strict auditing in England) is really looking for is an expression of opinion on the value of the bonds and shares of the company and on the policy of the managers. Such an opinion does follow to a certain extent from an audit in England, because of the business conditions; and much of our confusion of mind in the United States arises from the natural, but really incorrect, inference that the same thing must be true of an audit in America.

Conditions being different in the United States, auditing here has suffered from another cause also,—the necessary ignorance of the average accountant concerning the requirements for success in each particular line of industry. Again, let it be remarked, the art of accounting as defined abroad does not require this exact knowledge of each company's business to any great extent; but the different situation here, combined with the laudable wish to make auditing mean as much as in the old country, has led accountants in the United States to acquiesce in the common idea that they are expressing an opinion, directly or indirectly, upon the solvency of the company examined. In such attempts knowledge of the details of the particular business in hand is indispensable; and from the very nature of the case it is knowledge which must be hid from the majority of public accountants, who are called from the books of one concern in one line of trade to those of another whose profits depend upon different details altogether. Failures in the past and dangers in the future arise from this yielding of accountants to the pressure of public opinion for what is construed

to be a statement of values,—practically a judgment upon the company's prospects, which formed no part of the original purpose of an audit.

Instances of the perils of such construction upon the meaning of an audit are to be found even in the industrial history of England. The Allsopp brewery was sold to an incorporated company formed to take it over. The auditor certified to the profits of the previous year, and the shares, based upon his report, commanded a premium. But the expected profits were not forthcoming, and the subscribers to the new company suffered heavily. A public indignation meeting was called, and the auditor summoned before it. He stoutly insisted that he was right, and had done the whole duty required of a certified accountant; and so he had. It turned out that the profits of the year just before incorporation were exactly as found by the accountant, but were nevertheless unreal in the sense that in that year the cost of materials was lower than ever before. Thus these profits were no criterion of the future success of the new company. Had that accountant been a practical brewer, he would have noticed the fallacy in the books, so far as basing the future upon the past was concerned. One American example may be given. A trading company offered its shares for public subscription in a prospectus which contained an accountant's certificate to the effect that the accounts and bills receivable exceeded the accounts and bills payable by several hundred thousand dollars. When the company became embarrassed, it became known that the bills payable in the prospectus covered money owed to banks, while the accounts receivable were old book accounts due by customers, a good part of which were nearly worthless. Had the accountant been familiar with that business, he would not have couched his certificate in language which was technically true, but practically false, and which made the subscribing share-holders lose their money.

It is precisely this ignorance that is raising a prejudice against auditing in the minds of American corporation officers. They have given anxious thought to the questions of policy in conducting their business, let us say, and have agreed that certain things shall be done in a certain way and paid for from certain funds. Naturally they arrange their book-keeping to suit the facts as they understand them, for that is the very essence of good accounting. A chartered accountant is called in, perhaps to represent foreign shareholders, and proceeds to examine the books. Whether an American or Englishman, he is sure to find entries contrary to the strict and technical rules of the art in which he has been brought up. Having but a superficial knowledge of the business, he is unable to appreciate the explanations given by the company's managers, and perhaps thinks that he has grounds for suspicion. Against

the cross-questioning of such an auditor, and against the conclusions which he may feel impelled to draw, the officers enter complaint, and resolve not to subject themselves to the judgment of a man whose opinions cannot be as well founded as their own. No doubt we have in this paragraph the real reason why so many American companies remain deaf to requests for an audit of their books by a professional accountant. That this is not an exaggerated statement can be shown by another quotation from Mr. Tait:

"There should exist a class of carefully-trained professional accountants, whose word is law on all questions of accounts, and who care no more for the opinions of railway presidents on such subjects than they do for that of the least important member of their office."

That is the English theory, but it cannot be applied to the United States. Imagine a public accountant holding President Miller, of the Chicago, Milwaukee & St. Paul Railway up to the indignation of his English shareholders because his company showed a large surplus and paid but 4 per cent. in dividends! or the Chairman of the Louisville & Nashville, because a surplus of a million and a third was earned and no dividend declared! What professional book-keeper, by whatever name known, would set up his opinions on American corporation affairs in the manner indicated in our quotation? or, if he ventured to do so, would not be laughed down?

Another quotation will disclose one reason for Mr. Tait's extreme opinion: "The accountant must be familiar with all questions of law relating to accounts, as well as with the science of accountancy."

Accountancy cannot be scientific; the rigid rules which are applied to one set of conditions cannot be used under other and entirely different circumstances. The *art* of accounting consists in expressing in figures the facts as they really exist. Debiting and crediting are easy, if we are sure that the figures, after they are down, will accurately represent the business conditions; but, without this knowledge, after the best judgment obtainable, book-keeping will only mislead.

We are now in a position to see that the difficulty in which corporation-auditing is involved in the United States arises from the fact that not mere book-keeping is concerned, as is mainly the case abroad, but that a judgment is supposed to be passed upon the corporation's affairs and prospects, and that too by men who have not, and cannot have, given particular attention to the conditions of success in each line of industry. Until business in the United States becomes as stable as in England, the work of an expert book-keeper who has no opinions should be separated from the work of an expert business man or financier who has opinions and is competent to form

them. Public sentiment should stop the putting of exaggerated emphasis upon the certificate of a professional accountant, whether the same appears in a prospectus or in the annual report of a corporation. A chartered or certified accountant should put himself squarely in one category or the other; he should profess to be able to pass an opinion on the value of bonds and shares and the prospects of the business, or else he should distinctly have it understood that, like his English brother, his certification is confined strictly to the confirming of the figures as they appear on the company's books. As a matter of fact, it is rare to find good accounting and good financiering combined in the one person; and, as things go, there is room enough in the business world for both accountants and financiers. But, for the sake of clearness, a separation between the two professions should be insisted upon, not only in the interest of accountants, who are now suffering from responsibility thrust on them by the public demand for financial opinions, but also in the interest of the public, which is asking for a mature judgment on investments and is not getting it.

The objection will be made that taking opinion from accountancy will bring down the profession from its present high level. In the first place, if American accountants do not clear their reports from the implication of opinions on value, they will in time become discredited before their readers. But, aside from that, there is a large field, not half cultivated, in which good book-keeping must always be in demand. After all, it is a great benefit for the investor to know that the accounts of his company are kept free, not only from fraud, but from carelessness and from such a system of book-keeping as conceals the facts. An expert accountant need not be asked to pass upon the question, for example, whether a railway ought to carry a branch-line loss in any year as an asset in its balance-sheet; but, if he shall re-arrange the accounts, and so state them that what the company is doing in such cases is clearly shown, he will enable some one else, more competent, to give an opinion. In the Allsopp case, if, in addition to the accountant's certificate, there had been attached a statement from a practical business man or financier who knew the conditions in the brewing trade, it is easy to see how much loss would have been avoided; or, in the case of the American trading company, if the promoters had consulted some one familiar with that particular business, the subscribers would not have been deceived. Holders of corporation bonds and stocks should give up the idea that the certification contained in the annual report is anything more than a statement that the books are correctly kept, and that the report is a true transcript of them; if an opinion on the solvency of the company is desired, such holders should apply to those competent to give it.

ARE ELECTRIC CENTRAL STATIONS DOOMED?

By Max Osterberg.

PRODUCTION on a large scale for centuries past has been considered economical in all branches of industry and commerce. In fact, to contradict this would be almost equivalent to contradicting a geometrical axiom. Nevertheless our progress in electrical and other branches of engineering seems to suggest many points in favor, not of a radical overthrow of this theory, but at least of considerable modifications of existing methods. The writer will endeavor to show that the central station for lighting and power will, in course of time, outlive its usefulness. Just as its growth and development has given impetus to electrical engineering and educated the public to the advantages and comforts to be derived therefrom, so will its offspring, the small isolated plant, be the starting-point for a new era,—that long-looked-and-hoped-for condition where everybody may avail himself, not only of the advantages of the electric light, but of electric power as well, and possibly, too, of electric heating.

On what can we base this statement that the wholesale generation of electricity is more uneconomical than the production in isolated plants? What is it that reduces the expense in practically every known branch of manufacture, and that does not act likewise in this branch? It depends simply and solely on the cost of conveyance to the point of destination, and on the investment required to prepare the path for such conveyance.

Take, for example, the steam road; it is built from the various manufacturing centers to the points of distribution, and the interest on the capital invested in the line-construction is small compared to the value to be derived from manufacture on the large scale. Again, gas is obviously distributed from the outskirts of cities and towns, for the loss of pressure in the gas and even the large amount of leakage, as well as the iron pipes and their maintenance, cost but little in comparison to the value of real estate in the heart of the cities. With electricity, however, this does not hold. Copper, with its necessarily perfect insulation, costs a great deal; if we choose to work on the low-voltage system, the station must be located in or near the center of distribution; otherwise, the value of the copper required for successful service would be prohibitive. Aside from the fixed charges, such as interest and the number of k. w. which must be supplied to the line in order to prevent excessive drops, the generating expenses become exceedingly high. Mr. H. A. Foster, in the *Electrical Engineer*, Vol.

XVIII, p. 188, said that 5.4 cents per k.-w. hour would cover the cost of production.

It can be easily shown that we may install machinery in a corner-building of one block, and generate the electricity on a comparatively small scale at a greatly-reduced cost. Let us assume that we have obtained the permission from the owner of every building in one square block of, say, fifty houses to supply him with the electric current. We may run a steam or gas engine, and we may in either case have storage batteries. The latter become practically a necessity, since we certainly could not afford to keep our machinery running day and night. We can, however, run our engines from about 5 P. M. to midnight, so that only a small storage battery will be necessary for the remaining service. Since, however, in this first calculation, we do not care to include fixed charges, it is immaterial how the plant is installed. We require simply per 24 hours a certain number of lamp-hours. If the average house consumes 50 lamp-hours per 24 hours, then the fifty houses on this one block would require 2,500 lamp-hours, or 137 k.-w. hours. Allowing for losses in the distribution and efficiency of the electrical machinery, we should generate 186½ k.-w. hours. Five pounds of coal per h.-p. hr. would certainly do the work, and we would therefore require 1,250 pounds of coal per day, which, figuring the ton at $3.25, would be $1.81 per day. Allowing for attendance $2.50 per day, and for oil, waste, etc., 50 cents per day, we have a daily expense of $4.81, which per k.-w. hour is 2.31 cents.

Should we care to figure, however, on a gas engine, we should require but, say, 18 cubic feet per h.-p. hr. or, for 186½ k.-w. hrs, 4,100 cubic feet per day, which, even at the high price prevailing in New York city,—$1.25 per 1,000 cubic feet,—would be $5.62 per day. Attendance to the gas engine would be cheaper, however, since it requires no licensed labor to attend it. Adding $2.25 for labor and sundries, we should spend $7.87 for generating 186½ k.-w. hours, or 4.22 cents per k.-w. hour.

The principal advantage of this isolated block system lies in the fact that we have a direct distribution system without the necessary feeders and mains, which, besides their current consumption, involves considerable annual expense when the interest charges are considered. The calculation here presented for the steam plant could not quite be reached, if the boilers could not at the same time be used for heating the buildings; for, in the first place, water tax is not considered; in the second place, it would require too much coal to start fires every day, or keep them banked for eighteen to twenty hours; and, finally, no charge for firemen was added. The figures given for the gas engine,

however, can in practice be reached. Equal saving would be made, if oil engines were used in place of gas. Oil engines, at present prices of petroleum, can be run for about one cent per horse-power hour for machines of even one or two horse power, and, since the attendance required is very small, the price per k.-w. hour would possibly go below that of gas.

Suppose that we now choose a certain number of complete blocks, and compare the cost of installation of a large central station with a number of small isolated plants in that district. Take, for example, a section consisting of but half a square mile,—that is, ten blocks long and ten blocks wide, or, in all, one hundred city squares; assuming for each square the same amount of lighting which we figured on before, we should have to build one central station capable of supplying 250,000 lamp-hours per day, with a fair chance of nearly 60,000 lamps at one time,—that is, a station capable of furnishing 30,000 amperes at 110 volts, making a total of about 4,500 horse-power. Such a system would require forty to fifty miles of feeders and mains, regardless of the house distribution. These would require pretty nearly 500,000 pounds of copper, involving an expense of about $500,000 if we include cost of wire, insulation, and laying. Figuring the interest on this item alone at $30,000 per year, the 5,000 buildings would have to pay $6 each per year for the underground distribution. The site and construction of a power station in the center of the city would certainly cost $500,000 more. Machinery, consisting of boilers, engines, and dynamos, would easily add $250,000, and then we would but just be ready to generate our current, a considerable portion of which we should lose by the drop along feeders and mains. We are thus starting with a total initial expense, before entering the buildings, of say, $1,250,000. Were we to put a separate plant into each block,—that is, 100 in all,—with a proper storage-battery outfit and possibly gas engines for running the dynamos, $12,000 to $15,000 per block would easily supply machinery. The rent would be practically negligible, inasmuch as the house in which the plant is installed would be supplied with light at a cheaper rate or would receive a certain amount toward the salary of its janitor, who would take care of the plant. Each building would be charged *pro rata*. One hundred stations would thus have to be installed at a total cost of but $1,200,000 to $1,500,000,—an outlay about equal to that required for the large central station. As far as generating expense is concerned, we have shown already that the isolated plant is more economical than that of a central station. The question then arises how far such subdivision should go; for, since we were able to show that 100 small stations would be more advan-

tageous than one large one, why would not 5,000, or one in each house, be still cheaper? Or is it not possible that one station supplying four square blocks would be cheaper? The answer to this question depends entirely on commercial considerations. That one plant for, say, fifty houses would be cheaper than fifty single plants is obvious from the fact that very small machinery or very small storage batteries are not very efficient; but, with machines of 50 h. p., a practical commercial efficiency can in almost every case be reached.

Apparently, judging from the preceding calculations, the feeder and main system for transmission from central station to buildings, as essential as it may be be for good service, makes the use of electricity still too much of a luxury.

While it has thus been shown that the central station as such may, in course of years, cease to exist, the central-station management may still remain. For example, it might be very feasible for one engineer to take care of ten blocks, charging storage batteries every day. One central management could attend to the repairing of machinery, to the supply of coal where steam is used, or to the wholesale purchase of gas. If such a stage should be reached, pipes for fuel gas would undoubtedly have to be laid through our streets. This, of course, would again materially decrease the running expenses of our small stations, since gas could thus be supplied very cheaply indeed.

Mr. Perry, in his recent paper on "Gas versus Electricity for Power Transmission," published in THE ENGINEERING MAGAZINE, touched on several points which also have a direct bearing on the questions of transmission involved in this paper. He quoted, among other matters, some remarks made by Dr. Louis Duncan, who practically advises the concentration of power with an increased radius of distribution. Such a method, it appears to the writer, would be very uneconomical. It is not fair to compare the problem of railway engineering with the problem of lighting, the conditions being essentially different. In a lighting system we never have occasion (excepting in street lighting, which has not been considered here) to supply one long line extending several miles in one direction. A railway plant can, in almost every case, be included when we treat transmission plants, but cannot be included in the treatment of transmission and distribution combined, except in case of a large network of roads, whose common center could be supplied from one station, with separate plants for the outlying districts.

This question is not an entirely new one, but has frequently been raised. Its best and most obvious reply lies in the constant increase of isolated plants for large buildings.

FIRE-PROOF CONSTRUCTION AND RECENT TESTS.

By A. L. A. Himmelwright.

ONE of the most interesting special problems presented to architects and engineers in recent years is that of fire-proof construction. The fact that fire annually destroys a hundred million dollars' worth of property, or nearly one per cent. of all that we can produce, indicates how important is the subject of protecting property against fire. While the advantages of fire-proof buildings have no doubt been recognized and appreciated for many years, their cost and the experimental stage of fire-proof construction, as well as the uncertainty as to whether they would prove profitable investments, have deterred owners from erecting them. With the advent of our modern high buildings, however, fire-proof construction has become a necessity. The ordinary appliances available for extinguishing fires become inadequate when the objective point of the fire stream is higher than a certain more or less well-defined limit, depending upon varying local conditions. Some of the more recent high buildings are supplied with an independent fire-extinguishing apparatus,—a safeguard that should in all cases be provided in buildings more than one hundred and twenty feet in height.

Practical and efficacious methods of fire-proof construction have been perfected only in recent years. Previous to 1890 the subject of "fire-proofing" had received little scientific study, and the practical work was largely in the hands of ignorant workmen. As a consequence, very few of the so-called fire-proof buildings erected before that time are actually fire-proof. While suitable materials have in many cases been employed in these buildings, they have not been intelligently adapted or suitably disposed. Insignificant fires in such buildings have resulted most disastrously, and in some instances have utterly wrecked the buildings. Careful investigation of the physical properties of structural iron and steel when subjected to heat, and close observation of the effect of fire and water on different materials, have, within a comparatively short time, developed efficient and economical methods of "fire-proofing."

Fire-proof construction, as applied to buildings in general, embraces all methods of protecting the essential structural parts from being injured or destroyed by accidental fires. As applied to our modern steel-frame buildings, and as understood by the building trades,

"fire-proofing" may be defined as a special interior construction designed to confine accidental fires to the smallest practicable space, and to so protect the structural iron as to prevent it from being heated or distorted to such a degree as to threaten the safety of the building. The fire-proofing usually consists of some suitable material in the form of arches spanning the intervals between the iron floor-beams. It is also erected around columns, girders, and other exposed iron, and is employed for partitions.

In order that a building may be fire-proof, it is necessary that the fire-proofing material be not only incombustible, but also fire- and water-resisting,—that is, a material that "resists disintegration and retains its strength and firmness under all the conditions that may arise in the case of a conflagration and the subsequent operation of a fire department." The material must also be so adapted and disposed to the best advantage that the desired results are economically secured.

In buildings designed to be fire-proof, combustible material should be avoided as much as possible. The cost of the best materials frequently deters builders from using them, and more or less woodwork is still employed for the interior finish and furniture; this is an error, but conscientious designers now avoid it, and in the best types of fire-proof buildings the woodwork is largely replaced by metal, glass, cement, and stone. As illustrating the efficiency of some of the best forms of fire-proof construction in buildings with wood floors and trimmings, it may be stated that fires occurring in such buildings are controlled and extinguished without difficulty, and seldom cause serious injury to the building.

The present building laws of New York city prescribe that the spaces between all iron or steel floor-beams in fire-proof buildings shall be filled with common brick or stone arches, or with "sectional hollow brick or hard-burned clay, porous terra cotta, or some equally good fire-proof material, etc." The construction thus legally prescribed, while satisfactory in many respects when carefully executed, has nevertheless the disadvantages of being extremely heavy and very expensive. These disadvantages become more apparent as the depth of the floor-beams increases. The weight of this construction, exclusive of the iron beams, frequently exceeds one hundred pounds per square foot. Its immoderate cost in New York city is due primarily to the fact that the manufacture of the material is controlled largely by a trust, and secondarily to the fact that expensive labor must be employed in placing it.

The constant and increasing demand for fire-proof buildings has resulted in the development of forty-seven different systems of fire-

proof construction, designed to serve the purpose of the clay products, at a reduced cost. Some of these, based upon correct mechanical principles and contemplating the use of none but suitable materials, are unquestionably fire-proof in the broad sense in which the term is now used, and deserve to be recognized and ranked according to their merits. Tests of these systems have in some cases been made, but generally by interested parties, under different conditions, and with the details of the construction not quite as they would be in practice. The lack of exact knowledge respecting the various systems, and the desire to ascertain the relative efficiency and fire-proof qualities of each, have actuated the department of buildings of New York city to conduct a series of careful and exhaustive tests. Each system is subjected to a severe fire and water test under identical conditions. For this purpose suitable structures are erected, according to plans furnished by the department of buildings, by each party desiring to make a test.

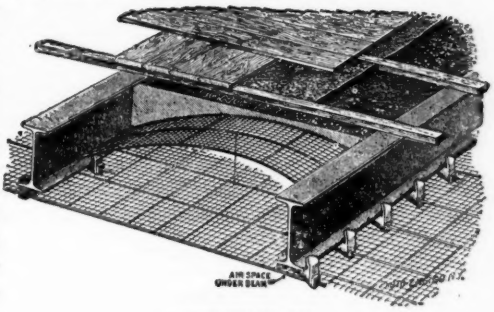
The test structure is built of brick, and is 13 feet by 17 feet in plan, outside measurement. Within the structure, at a height of 14 feet above the ground level, is erected the iron work designed to support the floor-system to be tested. Steel I-beams 10 inches deep, 25 pounds per foot, and spaced 4 feet center to center, are framed into girders resting on the end walls. The distance between the supports of the iron beams is 16 feet. The exterior walls are 13 inches thick, and are reinforced by buttresses or supported by suitable iron work, to prevent excessive cracking and bulging. At a height of about three feet above the ground level is constructed the main grate, which occupies the entire area of the building. This grate is in three sections, supported by two brick walls 13 inches thick, extending from end to end of the structure. In the three spaces between these two walls and the sides of the building, and about two feet below the main grate, are erected secondary grates. The fuel for the secondary grates is fed through three openings at each end of the structure, while that for the main grate is delivered through openings corresponding to a door at one end and a window at one side. The floor-construction to be tested is erected between the steel I-beams, thus forming three arches or spans of 4 feet each, and corresponding to the roof of the structure. Over the middle span and occupying an area of 4 feet by 16 feet is distributed the safe load of the iron beams, as fixed by the department of buildings, consisting of 150 pounds per square foot. In each of the four corners of the floor, openings are provided about twelve inches square, over which chimneys are built to a height of about six feet, to afford the required draught. A flat plastered ceiling is made under two of the floor arches or spans, the third being unplastered and pre-

senting the naked surface of the fire-proofing to the direct action of the flames. The draught is regulated by sheet-iron doors swinging on hinges at the various openings, and also by sheet-iron dampers on top of the chimneys. Dry, hard cordwood to the depth of 2 feet is piled over the entire area of the main grate, and enough kindling wood is placed on the secondary grates to ignite the fuel above. After the fires are started, fuel is added from time to time, and the draught so regulated that a high and uniform temperature may be maintained. The temperatures are indicated and recorded by a Uehling, Steinbart & Co. pneumatic pyrometer. After the fire test has been conducted for a period of about five hours, the flames are extinguished, and actual water effects are secured with the regulation hose and fire engine of the New York fire department. The fire stream is directed for fifteen minutes against the under side of the floor and the interior of the structure, after which the floor is flooded on top to a depth of six inches. The stream is then directed against the grates for two minutes, which concludes the water test. After the building has cooled off, the deflection of the floor is ascertained, and a test-load of 600 pounds per square foot is substituted for the safe load on the middle arch. This load is applied to ascertain whether or not such a floor in a real building would require renewal after equally severe subjection to fire and water. The floor, or a portion of it, is finally tested to destruction to ascertain its ultimate strength. The purpose of the fire on the secondary or lower grate is to heat the ingoing air, and thus produce a higher final temperature in the interior of the structure than would ordinarily be obtained. All tests are made about one month after the floors have been erected.

The tests already made, with a brief description of each system, follow in regular order:

I. The Roebling System, September 3, 1896.

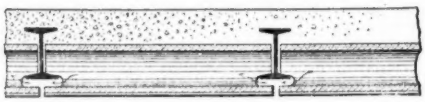
This floor consists of a wire-cloth arch, stiffened by woven-in steel rods or ribs; the arch is sprung between the I-beams, and abuts into the seat formed by the web and the lower flange of the beams. On this



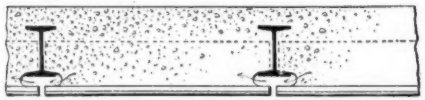
ROEBLING SYSTEM.

wire arch, which serves as centering, was deposited concrete consisting of 1 part of Aalborg Portland cement, 2 parts of sand, and 5 parts of steam ashes. The concrete was leveled flush with the I-beams, producing an arch having haunches about 9 inches deep, and a crown 3 inches thick at the middle of the span. Nailing sleepers, 2 by 3 inches, were laid crosswise over the tops of the iron beams at intervals of about 16 inches, and concrete, composed of 1 part of Portland cement, 2 parts of sand, and 10 parts of steam ashes, was filled between them to a depth of 2 inches. The flat-ceiling construction under two of the floor arches consisted of $\frac{5}{16}$ round iron supporting rods, attached by 1-inch offset clips to the lower flanges of the I-beams. Stiffened wire lathing was laced to these supporting rods, to which was applied machine-mixed mortar gaged with plaster of Paris. There was an air space, averaging about 4 inches in depth, between the flat ceiling and the floor arches.

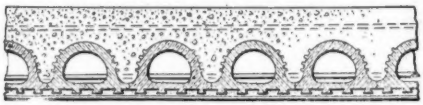
Details of Test. Duration of fire test, 11.10 A.M. to 12.58 P.M. Temperature: 12.01 P.M., 2,000 degrees F.; 12.10 P.M., 2,150 degrees; 12.10 to 12.45 P.M., 2,150 to 2,400 degrees. At the conclusion of the fire test the plastered ceiling and exposed concrete arch were red-hot. A portion of the brown coat of the plaster, 2 by 3 feet, had fallen away from the ceiling. After the water test half of the plaster was washed off of the ceiling, leaving the wire netting exposed at some places. The concrete floor arches, including the one exposed, were intact and uninjured. The final deflection of the I-beams, after cooling and removing load, was imperceptible. This floor was removed without further testing, and replaced by another for test No. V.



Longitudinal section through Lintel and Concrete.



Longitudinal section through Concrete.



Transverse section through Lintel and Concrete Filling.

FAWCETT VENTILATED CONSTRUCTION.

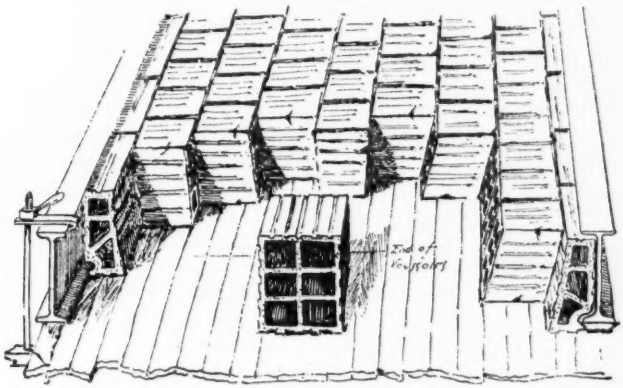
II. The Fawcett Ventilated System, September 10, 1896.

This floor consists of hollow terra cotta lintels about 6 inches wide on the flat side (which constitutes the surface to receive the plaster for the ceiling) and about 2 feet long. On the upper side the lintel presents a cylindrical surface. In a

cross section the hollow space is approximately circular in form, and about 4 inches in diameter. The ends of these lintels are designed to receive the lower flange of the I- beams, and be supported by them in such a manner that the flat sides of the lintels will be about 2 inches below the I-beams. The hollow spaces in the lintels thus constitute a connected air space about the lower flange of the I-beams. Ordinary lime plaster was used, the flat side of the lintels being provided with dovetails to receive and retain it. This system of construction requires that the I-beams be spaced at intervals of 2 feet. Six-inch I-beams so spaced, representing an equivalent carrying capacity, were substituted for the 10-inch beams, and rested directly on the end walls without framing as in the other tests. Concrete, consisting of 1 part of Atlas Portland cement, and 5 parts of steam ashes, was filled in above the lintels to a level of 2 inches above the I-beams.

Details of Test. Duration of fire test, 9.33 A.M. to 12.20 P.M. Temperature: 10.30 P.M., 1,850 degrees; 10.50 A.M., 2,200 degrees; after 11.20, large cracks had formed in the walls, and it was impossible to produce temperatures above 1,850 degrees. At the conclusion of the fire test the floor had deflected considerably, and the undersides of the tile lintels were red-hot. After the water test, the lintels had cracked off and fallen away over an area of about 20 square feet, exposing the concrete filling above. The plaster was off over the greater portion of ceiling. The following day the floor successfully supported the test load of 600 pounds per square foot. Final deflection of floor, considerable. The ultimate strength test was not made. The test structure has been torn down.

III. The Hollow Tile System, September 29, 1896.



HOLLOW TILE SYSTEM.
Showing Method of Laying.

The floor for this test consisted of Raritan, end construction, porous terra cotta, cellular blocks, 10 inches deep. These were built in between the I-beams in the form of a flat arch, the under surface of the arch being depressed 1 inch below the I-beams. The skew backs were each provided with an angle projecting under the I-beams, adjacent blocks along the same beam forming a dovetail which supported a soffit tile about one inch in thickness for protecting the under side of the I-beam. The blocks were about a foot square, with a special key for the center. They were laid in cement mortar, consisting of 1 part of Dyckerhoff Portland cement to 1 part of sand. Nailing sleepers, 2 by 3 inches, were laid over the I-beams, and concrete, consisting of 1 part of Dyckerhoff cement, 3 parts of sand, and 5 parts of steam ashes, was rammed in above the hollow tile blocks to a depth of 3 inches and levelled flush with the tops of the nailing sleepers. A thin coat of machine-mixed mortar was applied to the under side of two of the arches.

Details of Test. Duration of fire test, 9 A.M. to 3 P.M. Owing to difficulty in securing the necessary steam pressure and the absence of the assistant in charge of the pyrometer, no actual temperatures were recorded. Copper wires coiled around iron bars were inserted through openings in the walls occasionally, and were fused. This indicated a temperature of 2,000 degrees, approximately. At the conclusion of the fire test the under side of the floor was red-hot, and some of the plaster had fallen off. After the water test it was observed that the lower portions of the tile blocks, over an area of about 25 square feet, had broken away under the action of the fire stream, exposing the cellular spaces. The floor subsequently successfully withstood a test load largely in excess of 600 pounds per square foot. Final deflection, apparent. The ultimate strength test was not made. The test structure has been torn down.

IV. The Rapp System, October 26, 1896.

RAPP SYSTEM.

This floor consists of a layer of common bricks laid flat side down and supported by a series of light T-shape irons made of No. 14 sheet iron. These Ts are cut in lengths to fit at right angles between the I-beams, the flat side of the Ts resting on the lower flanges of the beams. The Ts are held in position, nine inches apart, by light iron spacers. Concrete, consisting of 1 part of Dyckerhoff Portland cement and 8 parts of steam ashes, was filled in above the layer of brick and leveled flush with the top of the nailing sleepers, 2 inches

above the I-beams. The under flanges of the beams were covered with wire lathing, and a thin coat of ordinary plaster was applied to the whole of the under side of this floor.

Details of Test. Duration of fire test, 10 A.M. to 3 P.M. Temperature at 11 A.M., 1,800 degrees. About an hour after the fire was started a piece of plaster falling from the ceiling disabled the pyrometer. Subsequent temperatures were indicated approximately by the fusing of copper wire. At the conclusion of the fire test the greater portion of the plaster had fallen away, and the under side of the floor was red-hot. Some of the light Ts supporting the brick had sagged down somewhat. After the water test, it was found that the fire stream had dislodged a number of the brick in the middle portion of the ceiling, exposing the cement filling above over an area of about 20 square feet. This floor later sustained the 600-pound test load successfully. Final deflection, imperceptible. Ultimate strength test to be made later. Test structure still standing.

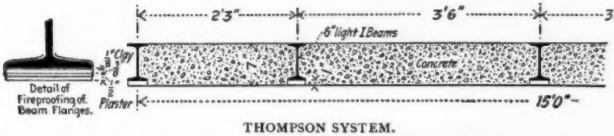
V. The Roebling System. Second Test.

The construction in this test was identical with that of Test I.

Details of Test. Duration of fire test, 10.06 A. M. to 3.06 P. M. Temperature: 11.30 A. M., 1,800 degrees; 12 M., 2,000 degrees; 12.43 P. M., 2,300 degrees. After 12.45 P. M. a uniform temperature between 2,000 and 2,200 degrees was maintained to the end. At the conclusion of the fire test the false-work and plaster had fallen down, the floor had deflected perceptibly, and the wire centering and the under side of the floor arches were red-hot. After the water test the floor arches were found to be apparently uninjured. The fire stream loosened a couple of the ribs of the wire centering, but had little or no effect on the floor arches. The following day the test load of 600 pounds per square foot was applied without any indication of failure. Final deflection, apparent. Ultimate strength test to be made later. Test structure still standing.

VI. Thompson System, November 7, 1896.

This floor consists of a solid monolith of concrete, spanning the



THOMPSON SYSTEM.

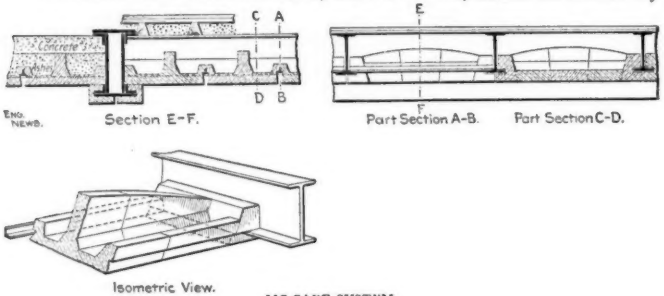
interval between the I-beams and projecting 1 inch below them. The iron work in this case consisted of I-beams 6 inches deep and weighing 13 pounds per foot. These were spaced about 3 feet 6 inches, center to center, and were framed into a girder resting on the side

walls of the structure, having a clear span of 12 feet. The concrete was composed of 1 part of Dyckerhoff Portland cement, 2½ parts of sand, and 6 parts of steam ashes. To this mixture was added, during manipulation, certain proportions of two other substances, the composition of which the patentees desire for the present to be withheld from publication. The under side of the iron beams was protected by a thin layer of a special compound designed to be a non-conductor of heat, which was held in position by wire lathing. Nailing sleepers, 1⅛ × 4 inches, were laid flat side down over the beams, and a low grade concrete filled between them, flush with the tops. Several different varieties of plaster were applied in sections to the under side of this floor.

Details of Test. Duration of fire test, 10 A. M. to 3 P. M. A temperature of 2,000 degrees was obtained about an hour after the fire was started. During the remainder of the test, the temperature varied from 2,000 to 2,300 degrees. At the conclusion of the fire test a large portion of the plaster had fallen away from the ceiling, and the under side of the floor was red-hot. After the water test the under side of the floor exhibited a slight depression, averaging about ¾ of an inch over about 10 square feet in the middle of the ceiling, where the fire stream had washed away a small quantity of the material. Final deflection after cooling, perceptible. The test load of 600 pounds per square foot was subsequently applied without any signs of failure. Ultimate strength test to take place later. Structure still standing.

VII. The McCabe System, November 9, 1896.

This floor consists of moulded, ribbed blocks, about 10 inches by



MC CABE SYSTEM.

2 feet in plan, built in the form of a flat arch between the I-beams. Small T-irons arranged at right angles to the beams at intervals of every two feet and resting flat side down on the lower flanges of the beams furnish the necessary supports during the erection of the arches,

and contribute to the strength of the floor. The blocks, consisting principally of a composition of plaster of Paris and steam ashes, are so designed that, when in position, their under surface is 2½ inches below the lower flanges of the I-beams. Steam ashes were filled in between the projecting ribs of these blocks, the surface finishing off in the form of an arch. On this filling was deposited concrete consisting of 1 part of Dyckerhoff Portland cement, 2 parts of sand, and 4 parts of steam ashes, the concrete being leveled flush with the tops of the I-beams. The usual 2″×3″ nailing sleepers were laid over the I-beams, and a low grade concrete was filled between them. Ordinary lime plaster was applied to the ceiling.

Details of Test. Duration of fire test, 10.00 A. M. to 3 P. M. Temperature at 11.20 A. M., 2,000°. After 11.20 A. M. until the end of the fire test a temperature above 2,000° was maintained, except for short intervals, while the fires were being replenished. At the conclusion of the fire test the ceiling was observed to be red-hot, some of the hard finish still clinging in shreds to it. After the water test the plaster and those portions of the plaster blocks projecting under the beams had fallen away. There were also a number of slight depressions in the under surface of the blocks wherever the fire stream had been allowed to play for any considerable period. At four or five places the plaster blocks were broken, and fragments had fallen away, exposing the concrete filling above. This floor sustained successfully the test load of 600 pounds per square foot. Final deflection, imperceptible. Ultimate strength test to be made later. Structure still standing.

The duration of the fire test in several of the earlier tests was not uniform, as it required more or less experimenting to establish a suitable period. A fire test of five hours, as finally adopted, together with the high and uniform temperatures produced, is probably more severe than that of an actual fire would ever be, except perhaps in warehouses for storing inflammable goods. The extreme tests are interesting, however, in that they bring out more distinctly the fire-resisting qualities of the different materials employed.

Other tests are to follow. A detailed discussion of the requirements of fire-proof construction and the relative efficiency and economy of the different systems will be given in a later paper.

NOTE.—We are indebted to *Engineering News* for the illustrations of the FAWCETT, RAPP, THOMPSON, and MCCABE constructions shown with this paper.

ENGLISH PRACTICE IN TRANSMITTING POWER IN MINES.

By a Staff Writer.

IT is only within comparatively recent years that very much attention has been given to the development of the underground machinery of mines. A main hoisting and pumping plant has always of course been a necessity, ever since there has been any deep mining by shaft, and very deep tunneling is a thing of modern date. The heavy surface plant has consequently been brought to an advanced stage of progress, and, while perhaps it may often look rough to those who are familiar with the machinery of factories only, it is on the whole very satisfactory, and in some directions, as in the case of the Cornish pumping engine and its connections, has reached a high degree of efficiency. But, in these days of sharp competition and increasing demand for rapid production, closer economies and better appliances are absolutely essential to profitable mining where the selling price of the product is low, as in the case of all coal and all iron ores, and indeed of the large majority of mineral products, for most of the mineral production now comes from ores which would have been considered very low-grade only a generation ago.

So in every department of mining great advances are being made, —because they have to be made,—and in none more than in the mechanical branch. Further, of mining machinery no division just now is of such interest as the underground plant, in which there are many improvements which are rendered possible only by the general progress in mechanical engineering in all directions.

Mining men all over the world should feel greatly indebted to Mr. Rankin Kennedy for his very able series of papers, recently given to the profession, on the transmission of power in mines.* Although Mr. Kennedy confines the discussion to British mines, and of these mainly to the collieries, principles are universal, and it is not difficult to see how the application must be varied according to conditions elsewhere.

Before going further, it must be said that no one who reads this memoir in full in the original can fail to be impressed with the conscientious attempt at impartiality with which the author handles questions which are the subject of somewhat acrimonious controversy between the

* "Transmission of Power in Mines." London *Electrical Review* for Aug. 7, Aug. 28, Sept. 4, and Sept. 11, 1896.

advocates of different systems and the makers of rival types of machinery. This is especially noticeable because the essay appears in a class journal and comes first under the notice of electricians, for whose benefit it is particularly intended. The *Electrical Review* is to be congratulated on obtaining for its readers a really fair summary of the situation from the point of view of one who, on the whole, favors electricity. Much harm has been done by the too frequent habit some people have of "claiming the earth" for electricity, or, as Mr. Kennedy puts it, asserting "the superiority of electricity over everything else," where it would be more instructive to compare it with other agents applied to the same purposes. He goes on to say that, in comparing these agencies for the various operations required in mining, it will be seen in what cases electricity is superior, and why it is so, and observes that it is necessary for electrical engineers to keep an eye on rival agencies and to investigate the possibilities of compressed air at its best.

The author, it may be remarked, considers only three competitors, —steam, compressed air, and electricity; and of these he limits the utility of steam pretty closely. There is however one other rival in the field,—hydraulic power, as applied in driving pumps in some European mines and in a few notable installations in the United States, the power water being supplied under great pressure, taken down the shaft to the hydraulic pumps in one pipe, and brought up in another or through a tunnel, thus securing a difference of head, the whole arrangement being a reversal of the principle of the hydraulic ram. Perhaps rope and rod transmission should also come into the comparison, for, although driven by steam or water and only transmitters, so also are electricity and compressed air only transmitters.

As a prime mover steam stands alone at the British collieries, and, if not applied direct, is the source of the other agencies. The author, in limiting his field to one set of mines, has omitted one of the great advantages of electricity in other places where water power is available, cheap, and sometimes even free, admitting of an installation of Pelton impact wheels or turbines at small cost, to run the generators, the power plant often being several miles from the mine and thousands of feet below it. There are a few examples of the use of water direct, to pump and hoist, as in some California mines, but these are exceptional. There is also a limited field, in certain localities, for the windmill as a source of power for generating electricity. But neither water or wind power are available at the British mines. Here is Mr. Kennedy's general comparison of the three agencies to which he limits the discussion:

"Steam differs from the other agents, as it is the direct product of

the natural elements,—water, air, and fuel. The energy, or at least a small part of the energy given off by the combustion of the fuel, is stored up in the water in a boiler; this energy converts the water into steam, and the energy is indicated by a pressure; this energy is converted into power by the steam engine.

"Compressed air cannot be directly obtained from the combination of elements; it must be compressed by some power generated and applied to the compressor. Compressed air acts only as a carrier of the power from the steam engine, waterfall, or windmill, to the place where the work is to be done.

"Electricity can be generated directly by the combination of natural elements on a small scale in the apparatus known as a primary battery, but at present this method is so expensive and troublesome that its use is confined solely to very light work, such as ringing bells and working telegraphs. Wherever any considerable power is required, we must get our electrical energy, as we get compressed air, from a machine driven by a prime mover, such as steam. Steam being the prime mover in all three systems, it is not possible, in making comparisons, to set steam aside. We can compare compressed air and electricity as transmitters and distributors of power, for both are alike in being merely carriers of energy, exactly as ropes or belts might be compared for the purpose of transmission of power; but, in all cases in mining work, steam power is the origin of the compressed air and electricity.

"We may compare the three systems from two points: first, the efficiency of the transmission, and, secondly, the efficiency of the conversion into work. We may then compare them for the purpose of ascertaining their relative convenience and adaptability. This latter point of view may be the most important in underground working, although efficiency is now more generally recognized as essential in colliery working than it used to be; some people argue that, as coal is very cheap at the pit, efficiency in power appliances is of little consequence; but that is now regarded by most colliery owners as a dangerous conclusion, and efficiency is insisted upon in most cases."

The purposes for which power is required underground are stated as haulage, coal-cutting, drilling rock, and pumping. To these might be added winze hoisting, lighting, signalling, and blast-firing—though the latter is done by small portable machines, and not, we believe, by taking current from the electric conductors.

The author considers that the use of steam below-ground can be seriously considered in only two cases: (1) where it is led below to the haulage engine placed near the bottom of the shaft, and (2) for steam pumps when similarly located. Here the chief difficulty arises

from the great length of steam pipe and consequent condensation. In another connection he notes the objectionable heat from the pipes and engines, which would preclude steam below-ground in some hot mining districts,—like the Comstock, for instance,—but which is not so important a matter in the English mines, except that in dry collieries it has a tendency to raise coal dust

All the British collieries are fitted out with steam engines for hoisting, to begin with ; then, as the workings extend, underground haulage by steam (with different methods of traction by wire rope, chains, etc.), so that compressed air or electricity must be adopted for rapid and economical traffic, though Mr. Kennedy seems to forget that slope mines and some shaft mines have the haulage engines at the surface. Pumping is often or usually necessary, and is sometimes very heavy. There are also requirements for power at the surface for the machine shop, coal screening and washing machinery, and transportation. The author follows Mr. Foster Brown in rating the steam engines used for these purposes in Great Britain as of low efficiency, using, say, not less than 8 pounds of coal per h. p. hour,—that is, not only for the steam used in actual work, but counting also that wasted by condensation, leakage, and fall in pressure in surface pipes ; so that Mr. Kennedy considers this figure too small, when long pipes are taken underground for pumping or haulage, and says that 10 pounds per h. p. hour would be nearer the truth, meaning this as an average for all the mines. Now, while coal is very cheap at the collieries,—and we suppose that in English practice a good deal of unmarketable coal is utilized in this way,—the high losses show very plainly why steam is an expensive agency underground, and also the need for something better. A correspondent of the *Electrical Review*, commenting on this point, calls attention to the fact that at several large collieries the boiler furnaces are heated by coke-oven gas. This would effect a large saving, as the fuel so used is a waste product, costing nothing.

As to the working of hoisting engines by electricity, Mr. Kennedy admits frankly that the electric motor is not an economical machine for working under the conditions of constantly starting and stopping, it being essentially a constant speed machine, if high efficiency is required. Every time it starts, which may be twenty or more times an hour, power is lost in overcoming inertia and getting up speed, which may take 20 seconds with a large motor. An analogy is drawn between the electromotor and the turbine, which it much resembles in this respect, for, if we jam up either so that it cannot move, a great stream of water or current of electricity, as the case may be, will run through without doing any work ; whereas a compressed air or steam engine wastes no fluid at all in starting, for, un-

less the piston moves, no fluid escapes. This is a small matter with electromotors running for hours at a time, but in a motor running only a couple of minutes or so, and starting twenty times an hour, it amounts to a great deal. Here it may be remarked that drills and coal cutters are also intermittent in action. Mr. Kennedy states that during the time from no speed to full speed the work done by an electromotor is only a fraction of the power applied; he places the loss at from 50 to often 70 per cent. Of course, as steam has to be used anyhow at the British collieries, and the boilers can be placed near the engines, there would be no reason for using anything else for hoisting, and, we may add, for operating a system of Cornish pumps. For all other purposes electricity or compressed air can, Mr. Kennedy asserts, be used to advantage. It is therefore a question of the comparative advantages or disadvantages of these two carriers of power. The case is very different in many of our western mining districts, where, because of the high cost of fuel, or absence of fuel, and availability of water power, electricity is used for everything, including hoisting; but there it is hardly a matter of choice.

Mr. Kennedy divides the treatment of the problem of power underground in collieries into: (1) the transmission of power in mines free from gas, and (2) in mines considered dangerous from the presence of explosive gases, so that in the first case we are at liberty to select a system quite different from and altogether inadmissible in the other case; and we think it may be well to interpolate the suggestion that it is not always easy to draw the line between fiery and non-fiery coal mines, since all are gaseous to some extent. But the author, an experienced engineer, recognizes that safety is the first consideration in mining, and explains that the application of electricity in fiery mines has been very cautiously approached. The danger is that of sparking at the brushes on the motors, and that of rupture or contacts made in the cables and switches. It is claimed that no accidents have occurred from sparking at the brushes, but this, Mr. Kennedy says, is no doubt due to the extreme caution of owners of fiery mines. He does not seem to think much of the "lame devices" for preventing sparking, and says that it is a foregone conclusion that motors with commutators and brushes will never succeed in dangerous places, but thinks favorably of the polyphase motor, which promises to get over the difficulty, having neither commutators or brushes. As to the wiring, he states that in a fiery mine it costs more than twice as much as in a non-fiery one, for all wires require to be buried and all switches to be inclosed in gas-tight iron cases.

Compressed air has the advantage that it can be used with safety ywhere, but it is pointed out that unfortunately the most important

improvement—that of reheating—cannot be applied in presence of gas.

The compressed-air systems have not stood still; improvements in compressors, pipe lines, and motors have been very great, so that for efficiency, it is admitted by Mr. Kennedy, it "runs electricity very close for long-distance transmission." He also notices the aid to ventilation given by the exhaust, but says that in collieries too much stress must not be laid on this, for efficient ventilation has to be provided for in any case. We might add, however, that in many metal mines in this country the exhaust from the air drills is the only artificial means of ventilation.

For obtaining isothermal compression the author does not believe in water jackets on the compressors or in water pistons, but prefers jet injection into the cylinder during compression. "The best method . . . is to use a compound compressor to carry out the work in stages, cooling the air to atmospheric temperature in intercoolers between each stage of the compression;" and "for mining purposes low pressures are desirable, especially in coal-cutting machinery [and rock drills], where flexible pipes are used, but, even if the pressure is only 50 to 60 pounds, compound compressors are an advantage." As to compression in stages, putting engines and air pumps on same bed, and development of mechanical details, like valves, the fitting of compressor pistons, etc., we think some credit should be given to American designers, who have taken the lead. As to efficiency, the following comparisons are made:

"By adopting compound compressors of recent designs with all the latest improvements, the cubic feet of air compressed per hour per horse-power has been raised from 264 to 367, a most decided advance, and power can be transmitted at a pressure of 60 pounds to two miles, distance without reheating at the motor with an efficiency of 50 per cent. on the indicated horse-power of the compressor engines; by reheating the air at the motors this efficiency rises to 70 per cent., which is a very good result, and is all the more significant from the fact that the compressed-air generator has the advantage over the electric generator, inasmuch as it can be run all the time at full load, owing to the ease with which air may be stored. The efficiency of compressed air, taking the brake horse-power of the compressors and the brake horse-power of the motor, is, with all improvements, 65 per cent.

"Compared with electricity, we may take the engine at 90 per cent. and the dynamo to average 85 per cent.; as in transmission plants the load varies considerably and is never long at a time full, we get $0.76 = 76$ per cent. efficiency at the best for the dynamo and engine. At full load we might get 93 per cent. for the dynamo and

90 per cent. for engine, giving 84 per cent. efficiency,—an efficiency actually obtained in some carefully-prepared full-load tests. We may make the efficiency of the conductor 95 per cent., and, taking the motor to average 90 per cent., we get a total efficiency of 71 per cent. for electricity, compared with 70 per cent. for compressed air reheated; such a result for air can only be obtained by expensive and considerably more complicated machinery than is the case with the electric plant. Nevertheless, we must admit that compressed air has made up in efficiency close enough to electric transmission to leave little room for choice between the two under that head. In a fiery mine a commutatorless motor would give an efficiency of 70 per cent., while the air motor due to the prohibition of reheating would only give 50 per cent. efficiency; it is only in safe mines, where reheating could be allowed, that the 70 per cent. efficiency can be obtained by air."

The cost of air pipes as compared with electric conductors, on points of first cost and maintenance, power for power, and for the same distance, is placed at 8:1 in a non-fiery mine and 4:1 in a fiery one. As to the air-power motors which are to do the work, not much is said, since they resemble steam engines so closely, except that the air is used with less expansion unless reheated. The great economy of reheating is shown by the fact that 15 pounds of coke per hour will reheat enough air for 80 h. p.

Mining engineers, as Mr. Kennedy remarks, are, as a rule, quite able to pass judgment on the engines, compressors, pipes, and air motors; but not many of them are able to see the good or bad points in electrical machinery. He goes into considerable detail as to the different types of dynamos and alternators, for which we must refer the reader to the original article. The author's judgment is that of the three types, single bobbin, bipolar, and multipolar, the first is good only for small sizes, the second being better up to 300 volts, and the multipolar best above 300 volts; he evidently prefers the multipolar in all cases. If over 300 volts is used, very careful insulation and wiring must be employed, though most persons could stand a shock of 500 volts and recover. As to the choice of continuous or alternating systems and two-phase or three-phase generators, and, in fact, all points of importance, we cannot do better than quote the author's general maxim that mine managers should consult an independent electrical engineer when about to order a plant. There is also another very good general rule,—that cheapness in first cost is not always economy.

Passing now to matters of installation which do not require expert electrical knowledge, Mr. Kennedy's remarks about wiring are that,

in non-fiery mines, the electrical cables, switches, and motors may be of the ordinary kind, and run without any special precautions,—ordinary 1,000-megohm rubber-insulated cable carried on porcelain insulators from the generator to the shaft, and hung on insulators down the shaft, with a protecting board fixed in front all the way down. Sometimes a pipe is fixed, and the wires run through that in the shaft. If the mine is dry, wood casing may be used below, but in non-fiery mines a good deal of liberty may be allowed in running wires, protection from personal contact with the conductors and from earth contacts being the only imperative requirements.

As to electrical coal-cutting machines, and for that matter all coal-cutting machinery, they do not make as much progress as might be expected. As Mr. Kennedy says, their chief advantage is not so much that the coal is got a little more cheaply, but that it is got without so much smashing and waste. Omitting the diamond prospecting drill, there are two kinds which are driven by electricity,—the auger drill for coal and soft rock, and the percussion drill. As to the latter, our American makes of air drills leave little to be desired, but Mr. Kennedy says that a good electric percussion drill is yet to be invented.

In fiery mines the use of electricity presents problems in everything; the wires, switches, and motors are required to be absolutely free from the possibility of sparking, and the utmost care in laying the wires should be required. The author gives his opinion as to the precautions to be taken, and describes some of the details. His final summing up of the case is, on the whole, strongly in favor of electricity, subject to conditions already noted. He says:

"In the non-fiery mine electrical transmission is cheaper in first cost and in maintenance, much easier applied, and higher in efficiency, than compressed air. In the fiery mine it is much more efficient, and with induction motors quite as safe, although difference in first cost is not so great."

The advocates of other agencies will, of course, take exception to this dictum, but, in justice to Mr. Kennedy, it should be stated that, to follow his closely-written descriptions and argument, his notable essay should be read in its entirety, for it is impossible in a review of moderate length to even mention all, or even a majority, of the points he raises.

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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Am. Chemical Journal. *b-m.* $4. Baltimore.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.*. $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
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Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
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Clay Record. *s-m.* $1. Chicago.
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Electrical Engineer. *w.* $3. New York
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Electrical Plant. *m.* 6*s.* London.

Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
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Electrician. *w.* 24*s.* London.
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Gas World, The. *w.* 13*s.* London.
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Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
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Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
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Locomotive Engineering. *m.* $2. New York.
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Machinery *m.* $1. New York.
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Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
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Stationary Engineer. *m.* $1. Chicago.
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Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
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Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

A Notable Heating Apparatus.

THE illustration herewith presented, together with a description condensed from *The Engineer* (London, Oct. 16), shows how the utilization of exhaust steam for heating may be carried out in a system of hot-water pipes of a bore generally considered much too small for such a purpose. It is an interesting example of how the knowledge of principles enables the engineer to surmount what at first seem insurmountable obstacles.

The head post-office at Manchester having been equipped with an electric plant, it was found that this necessitated the removal of the high-pressure heating apparatus in the basement, in order to make room for the boilers of the electric plant. It was desired to utilize the exhaust steam from the dynamo engines for heating, but at first it seemed necessary to remove all the piping hitherto employed, in order to carry out this desire. The building has in it twenty-four thousand feet of pipe, a large part of which is about what, in America, would be called ¾-inch pipe, and to remove and replace it by larger pipe adapted to exhaust steam heating in the ordinary way would have entailed a costly operation. In this dilemma Mr. J. W. Curra, an engineer of the post-office staff, bethought him of a method for using exhaust steam injectors without replacing the existing pipes. An experiment having established the feasibility of the plan, it was carried out as herein described and illustrated.

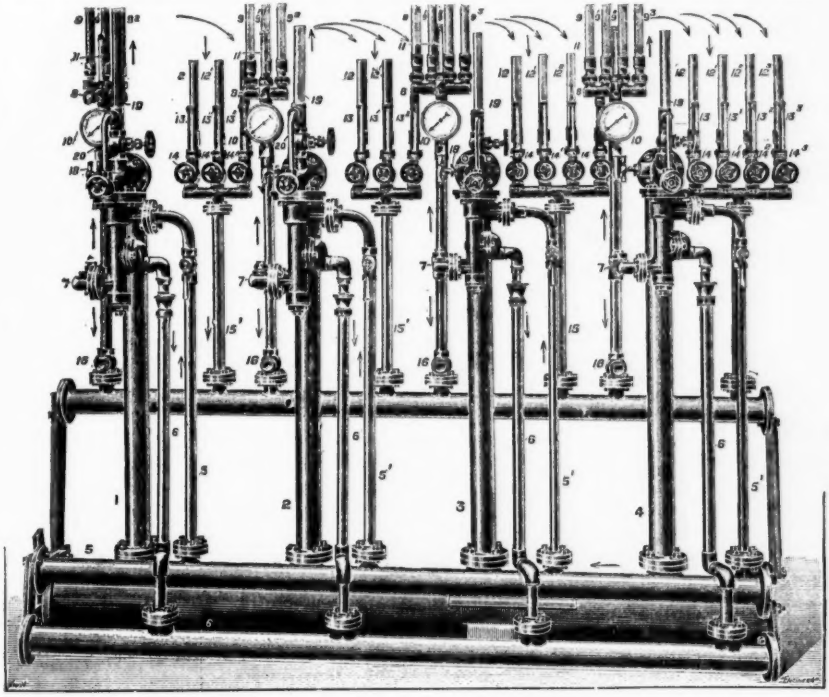
First of all, the twenty-four thousand feet of piping was divided up into twenty-eight separate circulating systems, sixteen for the offices on the ground floor and twelve for the instrument room on the second floor; experiments, however, showed it to be desirable to reduce the number of these systems to fourteen. Simple exhaust steam injectors were tried, but experiment led to the substitution of combined live steam and exhaust injectors, as the supply of exhaust steam might not at all times be available.

Four injectors are used for heating the circulating water, two being connected to the instrument-room circulations, and two to those serving the sorting-office and adjoining rooms. These injectors will together circulate through the pipes a total of 2,000 gallons of water per hour, at an initial temperature of about 200 deg. F., when using exhaust steam alone. They are connected above to the live steam pipes and the circulating heating pipes, and below to the main exhaust steam pipe from the electric lighting and pneumatic service engines, suction and discharge water pipes, and waste pipes. The heated water, after being passed through the circulating pipes, is returned by means of the common discharge pipe to a large cooling tank, forty-five feet long, placed in one of the open areas against the street, which cools the water so that it can be again taken up by the injectors and thus kept constantly circulating without waste, it being impracticable in this instance to take the boiler feed water from the heater.

Each injector is provided with a pressure gage and thermometer between its delivery outlet and the distribution boxes to which the circulating pipes are attached, and a weighted bye-pass valve is also fitted, which will pass a part or all the water delivered at once to the common discharge pipe, if circulation through the heating pipes is retarded or stopped. Each circulating pipe at its discharging end is provided likewise with a thermometer and a hand-wheel screw-down valve. The nicety with which temperature and flow can be regulated by means of these devices is considered a special feature of the system. The compactness of the arrangement will also be admired by heating engineers.

Exhaust steam is supplied to the injectors by branch pipes 1, 2, 3, and 4, leading off from the main exhaust pipe from the

electric light and pneumatic engines. 5 is the main water-supply pipes, and 5^1 the branches from it to the various injectors. 6 is the main overflow pipe, and 6^1 the four branches. The injectors deliver through the back pressure valves and pipes 7 into distribution boxes 8, whence the hot water is distributed into the flow pipes 9, 9^1, 9^2, &c., of the various circuits. The pressure gages 10 show the frictional resistance in the circuit pipes, and the thermometers 11 the temperature of the water as it enters the pipes. 12, 12^1, 12^2, &c., are the return ends of the various circuits 9, 9^1, &c.; and the thermometers 13, 13^1, 13^2, &c., show the temperature at which the water leaves the pipes, this temperature, or, in other words, the amount of hot water passing through each pipe, being regulated as required by means of the valves 14, 14^1, 14^2, &c. By means of these thermometers and valves the temperature of each circuit, and consequently of each room, throughout the building B, is under positive control, and capable of instant variation. The return water enters the pipe 15 by means of the branches 15^1, and passes on into a large tank, through which, after having quietly circulated and cooled down, it returns to the injectors again through the pipe 5. In case the various valves are so closed that the water delivered from the injector cannot get through, weighted bye-pass valves 16 are provided to enable a part or the whole of the delivery to "short circuit" into the return pipe 15; 18 is the wing valves controlling the exhaust steam; 19 a steam pipe and valve to work the injector by ordinary live steam in case the engines are not working; and 20 valves, supplying a small live steam jet sometimes placed, as in the present case, in the injector to give additional force to the injector when such is required. If required,



HEATING APPARATUS, MANCHESTER HEAD POST-OFFICE.

the injectors may also be employed for feeding the boilers direct as well as supplying the heating pipes.

The Heating Plant of The University Building, New York.

THE one-pipe system of steam-heating is a system wherein the water of condensation is returned from radiators or coils by gravity through the same pipes that supply the steam. The two-pipe system is one in which the water from steam condensed in the radiators is returned to the boiler through separate pipes. In the latter system each radiator has an inlet for steam and an outlet for water to which, respectively, the steam and return pipes are fitted. In the one-pipe system the steam-supply pipe is screwed into a single inlet which, while admitting steam, also serves as an outlet for the water, which flows along the bottom of the horizontal connection back to the steam riser pipe, falls through it to the steam main at the bottom of the riser, and thence flows along the bottom of the main back to the boiler.

The one-pipe system has been more extensively used in the western than in the eastern part of the United States, and, in buildings of moderate size, has proved very successful when skill and good judgment have been used in its installation. So far as we know, the building named in the title of this review is among the first, perhaps the first, to apply the system to the heating of tall buildings.

Our excellent contemporary, *The Engineering Record* (Sept. 19), gives an illustrated description of this installation, the main features of which are as follows:

The exigencies of the building, it appears, demanded the use of both the two-pipe and the one-pipe systems, in order to meet the desired requirements as far as possible. The building is one hundred by one hundred and seven feet in plan, and is eleven stories high. The first seven stories are heated by the two-pipe system, while the four upper stories are heated by the one-pipe system. The arrangement well illustrates the fact that nearly every heating installation has peculiar conditions, which must be met in the design of the apparatus, and the consequent fact that rule and precedent can guide the designer only in such features as are ordinarily met with. Beyond this he must rely upon his knowledge of principles.

As the eighth and ninth stories are used as lofts,—a large printing establishment occupying the basement and the first stories,—and as the tenth floor is to be occupied by a law school, while the upper part is to be divided into artists' studios, it will be seen that three general sets of conditions are presented in one and the same building,—to wit, a manufacturing establishment, a school, and a series of comparatively small rooms. Heating engineers will readily appreciate the difficulty in working out a design that will entirely and satisfactorily meet these several requirements simultaneously.

Another peculiarity of the building is that above the seventh floor, which supports the large printing presses, the walls of the building are materially thinner, and their lines change. While wall coils are used below the eighth floor, the law school and the studios are heated partly by radiators and partly by coils. Here is enough to render both design and satisfactory execution more than ordinarily difficult, but the adoption of the two separate systems opens a path for the designer. The one-pipe system heats practically the two consecutive upper stories only, and the main difficulty in it is thus reduced to meeting different sets of conditions pertaining to the school and the studios.

The stories so heated are supplied by a six-inch pipe "which is carried through a pipe-shaft to the eleventh floor, where it divides into two branches, which nearly make the circuit of the floor," and from this risers are let down to the radiators on the tenth floor.

As much steam has to be supplied for power purposes, both the power plant and the heating plant working harmoniously, it will be understood that a good piece of engineering work was required in this installation. The special design will interest engineers. Our cotemporary does not state whether the results desired have been fully attained or not, but its detailed de-

scription and illustrations form an interesting study to heating engineers. The ventilation is effected by fans, etc., and other interesting points are worked out in the design, information upon which is supplied in the article thus briefly reviewed.

Self Helps.

ALL original art is intimately connected with the exercise of the power of imagination. The cultivation of the imagination and its severe discipline into artistic bounds are fundamental principles in art education. Architecture is an art, in the highest sense of the term. The supervising architect is called upon to exercise business qualities more than the painter or the sculptor; but, notwithstanding, his ability to conceive beautiful forms and to arrange these in groups pleasing to the eye must have been widened by study and the education of his imaginative power, which cannot be subordinated to business, if he would ever achieve anything great in his profession.

Mr. A. B. Bibb, in *The American Architect* (July 11) talks pleasantly and sensibly of self helps in the cultivation of the qualities essential to success in architecture. Among other things, he speaks of the books whose perusal will aid in cultivating the imagination, and thinks that books devoted to architecture, painting or sculpture should not alone be relied upon as aids to the development sought.

"We are too prone to be matter-of-fact, even at our best. The irksome requirements of actual practice tend so often to crush out the dreamier qualities which go with every flight of the imagination that, in the rush of business, we may forget the satisfaction and the real growth that might come to us by at times following the intellectual revelry of a work such as the 'Arabian Nights,' 'The Ancient Mariner,' Prescott's 'Conquest of Mexico,' or Rudyard Kipling's 'Jungle Stories.' Indeed, I know of no better literary antidote for architectural affectation than to travel with Mowgli through the romantic imagery of the jungle, letting our fancies run their own pace in a world which is new to us, leaving us with a clearer vision and a truer perception for the practical, tangible art with which we have to grapple. If I were obliged to choose between fiction and Viollet-le-Duc as a course of reading for an architect, my reason might carry me to the latter; but I firmly believe more growth would come in the long run from a little literary dissipation than from scientific indigestion." "Scientific indigestion" is a decidedly happy expression as characterizing the condition of a certain too numerous class of mental dyspeptics turned out under the cram principle of the modern system examinations. Carrying out the simile it may be added that it often relieves a tendency to such indigestion to fill the mental maw with food that requires little or no alteration to prepare it for assimilation, even if it lack nutriment.

Strength of Georgia Pine.

MR. HARRY H. MILES, in *The Southern Architect*, describes experiments made by him with a view to determine the strength of Georgia pine, a timber extensively used for building purposes. He found difficulty in holding his test pieces so that they would break through the smallest section, the gripping devices injuring the grain of the wood so much that breaking is apt to occur through the injured grain, instead of the test section. From this he concludes that, when this timber is used for tie rods, etc., the estimate of its strength should be made from strain required to pull out the fastenings, from the shearing or splitting of the wood, etc., and not from the tensile strength of the solid pieces.

The strength of the timber depends upon the degree of seasoning, the part of the tree from which the test piece is taken, and the position of the grain in relation to the direction in which the strain is applied.

From twelve tests of "green timber taken from all parts of a tree, an average modulus of rupture of 9,313 pounds per square inch was determined. Seven tests of seasoned timber gave an average modulus of rupture of 10,524 pounds per square inch, showing that seasoning adds about thirteen per cent. to the strength of the green timber. The strongest timber is in the

butts of the trees, and the heart is stronger than the sap-wood in all parts."

A discrepancy between the modulus of rupture and the tensile strength of the material (the average tensile strength being 15,217 pounds per square inch, while the modulus of rupture is 9,786 pounds) is thus explained.

"When a beam is subjected to a transverse load, the part of the beam on the side next the load is subjected to compression, and the other side to tension, and, since the compressive strength of pine is less than the tensile strength, the side next the load gives way first, and offers less resistance than it did, having the effect of decreasing the depth of the beam, or shifting the neutral axis towards the tension side of the beam. In all the beams tested it is plainly visible that the compression took place in more than half the depth of the beam, showing that the neutral axis was shifted; this would cause the modulus of rupture to be less than the tensile strength.

"When rupture of the fibers takes place, the beam is considerably deflected, and the fibers are not under a straight pull, but are pulled around a curve, and would therefore be weaker than if they were not bent."

The tests for compressive strength were made upon two-inch cubes. The average for thirteen tests was 5,498 pounds per square inch, for end compression, the heart being far more resistant than the sap, and seasoned timber more resistant than green timber.

"Testing for compression across the grain, it was found that the strength depended almost entirely upon the position of the grain. The specimens stood all the way from 1,200 to 12,000 pounds per square inch. When the grain was flat, the material would stand a very great stress without collapsing, although they were compressed to about half their original size. While, if the grain was placed vertically or diagonally, the pieces would stand very little stress before giving way."

Mr. Miles says that the specimens tested were more perfect than could be found in commercial timber, and recommends a reduction of the figures to 8,000 pounds for modulus of rupture and 4,000 for compressive strength, with six as a factor of safety.

Would it not have been better to give us the average figures for just such Georgia pine as enters into commerce, instead of tests of far better timber, from which a guess must be hazarded as to the figures that may be considered safe in actual practice? What is the use of a series of tests, if the final application is to be by guesswork?

The T-Square Club.

WE have received the thirteenth annual report of the T-Square Club of Philadelphia. The document is interesting in several respects. In the first place, it is printed in an artistic style, worthy of the art to which the membership of the club is devoted. Secondly, it plainly shows that the society may become an active and earnest factor of advance in the art of architecture in the United States. The club was founded in 1883. At first planned for the advancement of its individual members, it has now come to a stage of development wherein it can make its influence felt upon broader lines, and it has manifested a tendency to do this during the past year.

The lecture course of the architectural department of the University of Pennsylvania has been made available to the members of the club, who, at the close of the year ending October 23, 1895, numbered 118, but now number 133, notwithstanding losses during the year by death, resignation, and other causes.

Besides the lectures of the university course, special courses of lectures by able practising architects and professors of architecture in institutions of learning have been planned and carried out. A system of competitions has also been organized. A feature of the competition for this year has been the first annual prize re-designing competition. This is an innovation in competitions.

The society will hold an architectural exhibition in connection with the sixty-sixth annual exhibition of painting and sculpture at the Pennsylvania Academy of

the Fine Arts, beginning on December 20, and continuing till February 2, 1897. The report says that this exhibition "will be the consummation of an idea which was first suggested to the club by Mr. Frank Miles Day and Mr. Edward Hurst Brown, in November, 1888. At that time a committee of T-Square Club men, consisting of Messrs. Eyre, Johnson, and King, was appointed to confer with the officers of the Academy, with the object of securing the use of a room during the annual exhibition for the display of architectural designs. Their overtures were approved of, and the desired space was allotted for the first architectural exhibition, which subsequently was prepared by a committee of architects composed of representatives from the local Chapter of the American Institute of Architects, and the executive committee of the T-Square Club.

"Those who have consulted the list of names making up the various architectural exhibition committees since then will find that, with few exceptions, they have been all those of T-Square Club men. This being fully realized, it was but natural that ultimately the exhibition should be held in the club's name.

"At this early date the exhibition committee deem it unwise to make any report, further than to state that all the preliminary arrangements have been made, and that they trust that its management may deserve the confidence of every one concerned, and it is also greatly to be hoped that both the Academy of the Fine Arts and the T-Square Club may reap mutual benefit of sufficient worth to make the present affiliation a permanent one.

"The T-Square Club has been conceded privileges by the Academy which should be greatly appreciated."

Altogether, the prospects of the club seem bright, and indicate a widening field of usefulness.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

CONSTRUCTION AND DESIGN.

*8658. The Cantilever as Applied to Building Construction. Ill. John Beverley Robinson (Pointing out the lines along which a new style of architecture may develop). Eng Mag—Nov. 4000 w.

8678. The Reibold Building, Dayton, O. (First part gives general plan, elevations and sections; wind bracing in walls; diagram of floor beams; details of columns and general description of design and construction). Eng Rec—Oct. 10. 1400 w.

8686. Stables. C. H. Blackall (The first of a series of articles on things to be considered in the construction of stables). Am Arch—Oct. 10. Serial. 1st part 2500 w.

8718. The Poulson Metal House (Illustrated description of a fireproof building which presents some unusual features obtained by the combination of iron and copper for exterior and interior construction and ornamentation). Sci Am—Oct. 17. 900 w.

8755. The Foundations of the New York Cathedral. From "Builders' Reporter." (Brief account of the difficulties encountered and overcome in laying the foundations for the new cathedral at Morningside Park, New York). Can Arch—Oct. 1900 w.

*8765. Fireproof Floors (Results of some experiments made at Berlin, under the auspices of the Royal Police Fire Brigade). Ill. Car & Build—Oct. 9. 2800 w.

8766. Safe Spans for Wooden Floor Joists, Ceiling Joists and Rafters in Buildings. F. E. Kidder (Tables showing the size of wooden joist to be used with the ordinary method of framing, with remarks). Arch & Build—Oct. 17. 800 w.

8792. Handling a Heavy Foundation Girder in a Tall Building (Describes the handling of a triple-webbed plate girder 52 ft. 6 in. in length, 61¼ inches in height, 2 ft. 6 in. in width and of a weight of about 37 tons, in the Queen Insurance Co.'s building, at Cedar and William streets, New York). Eng Rec—Oct. 17. 1300 w.

*8908. The Chemistry of Certain Metals and Their Compounds Used in Building, and the Changes Produced in Them by Air, Moisture and Noxious Gases, &c. John M. Thomson (Some of the changes which materials used in building undergo through the action of time or exposure to vitiating agents). Jour Soc of Arts—Oct. 16. 6000 w.

*8941. A Remarkable House (Illustrated description of a dwelling, devised by Dr. W. Van der Heyden, and built in Yokohama. It is constructed to shield the inmates from extremes of temperature, for economy in the use of fuel, pro-

tection against earthquakes and perfect sanitation). Engng—Oct. 16. 2500 w.

†9013. High Buildings. A. L. A. Himmelwright (An interesting discussion favoring high buildings and considering the arguments against them). N Am Rev—Nov. 2400 w.

*9022. American Building (An extended review of a recent work by F. E. Kidder, descriptive of American practice). Arch Lond—Oct. 23. 3400 w.

9101. London Public Conveniences (Illustrated description of an underground public convenience erected in London, and now generally adopted in English cities). Eng Rec—Nov. 7. 1300 w.

9104. Principles Governing the Design of Foundations for Tall Buildings. Randell Hunt (Read before the Technical Soc. of the Pacific Coast, April 3, 1896. The origin, characteristic construction with its advantages and disadvantages, &c.) Arch & Build—Nov. 7. Serial. 1st part. 4000 w.

9128. National Architecture; Certain Considerations Which Might Possibly Affect the Design and Construction of Our Buildings. William Martin Aiken (Read at the 30th An Con of A I A. Memoranda of principles, tending to the begetting of logical architecture). Am Arch—Nov. 7. 1700 w.

9129. Influence of Steel Construction and of Plate-Glass Upon the Development of Modern Style (J. W. Yost and Robert D. Andrews contributed papers on this subject to the 30th An Con of the A I A. Mr. Andrews treats the subject in regard to the effect on masonry design. Mr. Yost calls attention to the change in proportions of modern buildings due to steel construction and the general advantages and additional comfort to mankind from the use of these two materials). Am Arch—Nov. 7. 4500 w.

*9130. Glasgow Cathedral. T. L. Watson (The writer calls this the most important and most interesting building in Scotland. Part first gives a brief history of the building and a partial description of the design). Arch, Lond—Oct. 30. Serial. 1st part. 1700 w.

HEATING AND VENTILATION.

8754. Ventilating and Warming Stables (A dissertation upon the essentials of warmth and ventilation necessary to maintain the health of horses kept in stables; the amount of cubic space required per horse and the proper size of stalls). Can Arch—Oct. 2000 w.

8868. English Boiler Connections. Frederick Dye (Illustrated description and differences between English and American practice). Heat & Ven—Oct. 15. 2400 w.

8869. French Methods of Heating and Ventilating. G. Debesson (Principal French methods will be described. Part first deals with the possibilities of the introduction of American goods and methods). Heat & Ven—Oct. 15. Serial. 1st part. 1300 w.

8870. Warm Air Heating. S. Hampton Ripon (The subject will be discussed under five divisions. The first part is introductory and consists of general remarks). Heat & Ven—Oct. 15. 1000 w.

8871. Ventilation of School Buildings (Paper read before the Am Inst of Instruction, Bethlehem, N. H. Practical illustrated dissertation upon the inexpensive means of improving the ventilation of school buildings which have not been provided with adequate systems). Heat & Ven—Oct. 15. 2000 w.

8885. Indirect Heating in a New Haven Residence (Illustrated detailed description). Eng Rec—Oct. 24. 700 w.

9103. Heating of the Malden (Mass.) High School (Illustrated detailed description). Eng Rec—Nov. 7. 1000 w.

LANDSCAPE GARDENING.

8780. Park Lands and Their Boundaries (Editorial suggested by an article by Charles Eliot, in the New England Magazine, giving a sketch of the park system of Boston. The need of public parks in our large cities). Gar & For—Oct. 21. 1300 w.

PLUMBING AND GAS FITTING.

8674. Diameter and Inclines of Drains. A. B. Plummer (Abstract of paper read before the Sanitary Institute Congress at Newcastle-on-Tyne. Description of interesting experiments with flush tanks and drains, the object being to minimize the amount of water required for effective flushing). Arch & Build—Oct. 10. 1800 w.

*8784. The Plumbers' Craft and Education. Prof. Garnett (The remarks are directed to the better protection of the public health through the plumbers' art and to increased appreciation of the plumbers' work). Dom Engng—Oct. 1400 w.

*8785. Most Common Defects (As an aid to inspection, the most common defects are illustrated and described). Dom Engng—Oct. Serial. 1st part. 500 w.

*8786. The Trap on the House Drain (Against a current belief that traps on house drains should be abolished are opposed facts and experience). Dom Engng—Oct. 600 w.

*8787. Main Drain Traps and Their Disadvantages. F. W. Tower (An argument against the use of main drain traps). Dom. Engng—Oct. 1700 w.

8793. Plumbing in a Reconstructed New York Residence (General illustrated description). Eng Rec—Oct. 17. Serial. 1st part. 1600 w.

8878. New York Plumbing Regulations (Text of the recently revised code of the building department). Met Work—Oct. 24. 5500 w.

8879. Lead vs. Iron for Supply and Vent Pipes, from a Plumber's Point of View. William Eccles, in the Gas Light Journal (The question considered from an engi-

neering point of view leads to the conclusion that galvanized iron will eventually almost wholly replace lead for supply pipes, while asphalt dipped black iron is better for discharge pipes in the plumbing of buildings). Arch & Build—Oct. 24. 1100 w.

MISCELLANY.

*8679. Some Sanitary Points in House Building. R. H. Ellis (Suggestions for choosing a site, character of the ground, precautions to prevent dampness in walls, and for smoky chimneys are dealt with in part first). Ill. Car & Build—Oct. 2. Serial. 1st part. 1800 w.

*8680. Builders' Ironmongery (Part first considers the branches into which the trade may be divided. The first of a series of articles aiming to help builders who feel the need of assistance). Ill. Car & Build—Oct. 2. Serial. 1st part. 1800 w.

*8682. North London House Property (Illustrations indicative of the class of modern houses built in this district, with some particulars and notes). Ill. Car & Build—Oct. 2. 2500 w.

†8709. The Temple at Deir-el-Bahari. Edouard Naville (Illustrated description of a beautiful Egyptian temple recently brought to light). Jour Roy Inst of Brit Arch'ts—Sept. 17. 2500 w.

†8710. International Competition for Theatre, Kieff (Account of a theatre to be built in a Russian town, in plans for which architects of all nations are invited to compete. Regulations for the competition are given, with plans). Jour Roy Inst of Brit Arch'ts—Sept. 17. 1500 w.

*8742. Government Tests of Building Stones (Report of J. W. Reilly concerning the scope of the tests made at the U. S. Arsenal at Watertown, Mass. Illustrated). Stone—Oct. 1800 w.

8743. Estimating from Bills of Quantities. G. Alexander Wright (Recommends the adoption of a national system of estimating from bills of quantities). Am Arch—Oct. 17. 3300 w.

8753. Loads and Strength of Roofs. From the Contract Journal (Calling attention to the dead and live loads necessary to be considered in making estimates of the weights of roofs). Can Arch—Oct. 2000 w.

*8900. An Architectural Symposium (Report of a talk on the aims and position of modern architecture in one of the lecture rooms of the Architectural Association, London). Builder—Oct. 17. 2200 w.

*8902. The Evolution of Christian Architecture (Abstract of address by Prof T. Roger Smith at University College. Brief review of important steps in its progress). Arch, Lond—Oct. 16. 900 w.

*8903. The Church and Art (Abstract of paper read by Mr. Holman Hunt at the conversazione given in the Music Hall during the Church Congress. Refers to early prejudice against painting and sculpture in the church, and traces the influences which have changed public opinion). Arch, Lond—Oct. 16. 1200 w.

†8909. The Letting of Contracts. Geo. Beaumont (Address before the Building Trades Club, of Chicago. Discusses the various difficulties and suggests remedy). In Arch—Oct. 2800 w.

8912. The Application of Sheet Zinc for Roofing and Other Purposes. W. H. Seamon (Much interesting information relating to the zinc industry is contained in the article. Part first deals largely with the use of zinc in roofing). Eng & Min Jour—Oct. 24. 1700 w.

*9024. The Analysis of Mortar. W. J. Dibdin and R. Grimwood (Read at the Summer meeting of the Society of Public Analysts and published in the Analyst. Provisions made in the by-laws of the London County Council with methods of analysis and experiments). Arch, Lond—Oct. 23. 2500 w.

9025. The Training of Workers in the Applied Arts. Robert Anning Bell (Read before the Liverpool Society, Nov. 11, 1895. Describes means of attaining results that the writer considers desirable). Arch & Build—Oct. 31. 3000 w.

†9041. Work of the Committee on Fire-Proofing Tests. S. Albert Reed (The co-operative committee of three, representing the Fire Insurance Underwriters, the Architectural League and the American Society of Mechanical Engineers. Interesting information with tests thus far made). Jour Fr Inst—Nov. 4000 w.

9096. Tests of the Roebling Fire-Proof Floor (A protest was sent to the N. Y. Building Dept. claiming that the two hours' test was not sufficient, so a second test for a period of five hours was made and is here described). Eng News—Nov. 5. 800 w.

*9132. Metal-Work Exhibitions, Glasgow (Illustrated description of exhibits). Builder—Oct. 37. 1300 w.

*9145. The Early Renaissance in France. G. A. T. Middleton (Illustrated description of examples of this type of architecture with comments). Arch Rec—Oct.-Dec. 2000 w.

*9146. Sculpture as Applied to the External Decoration of Paris Houses. Fernand Mazade (Illustrated description of some of the applications, with record of the progress in the last twenty years). Arch Rec—Oct.-Dec. 4200 w.

*9147. Perspective Illusions in Medieval Italian Churches. William H. Goodyear (A study with illustrations of the churches of Italy, giving especial attention to the churches of Pisa). Arch Rec—Oct.-Dec. 7000 w.

*9148. The Works of R. H. Robertson. Montgomery Schuyler (Biographical sketch with illustrated description of his most important works and favorable criticisms). Arch Rec—Oct.-Dec. 9000 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Bridge Work.

THE engineering papers of late have been profuse in their illustrations and descriptions of new bridge structures. A glance at our index of civil-engineering literature for the current month and for several months previous will show the importance and magnitude of this branch of civil engineering as compared with other branches. Two very interesting specimens of bridge work have been recently described and illustrated,—one over the Harlem river at Third avenue, New York city, and another designed to bridge over Newtown creek, affording a passage from Vernon to Manhattan avenues on the Brooklyn side of the East river. The former, ilustrated and described in *Engineering News* (Nov. 5), is one of the largest and heaviest draw-bridges ever constructed. The latter, described and illustrated in *The Engineering Record* (Oct. 31), is a bascule bridge, operated by hydraulic rams and counter weights. It is said that the design of the latter, prepared by Thomas E. Brown, Jr., of New York city, has been definitely adopted by the Queens county board of supervisors and the Brooklyn board of aldermen. The design has been accepted against considerable competition with other designs, which included the Waddell system of lift bridge and the Breithaupt interlocking arch segments with suspended floor. A description of the Waddell's lift bridge over the Chicago river at South Halsted street, Chicago, was printed in *The Engineering Record* and in other engineering papers in the spring of 1893. The Breithaupt system of interlocking arch segments with suspended floor was illustrated and described in the newspaper named, in its issue of August 8, 1896.

Mr. Brown's design differs materially from the bridges of Waddell and of Breithaupt, its special features being shown in diagrams and described in *The Engineering Record* (Oct. 31). Those who wish to study the details must consult that article, which says that "the essential elements" of the design "are a double bascule, the free ends of which are supported when under traffic by movable, vertical columns seating on the river-bottom; heavy constant counterweights with points of attachment automatically shifted to correspond with successive positions of the centers of gravity of the revolving bascules, and of the operation of each leaf of the bascule by two pairs of horizontal hydraulic cylinders, working directly through simple pairs of links without ropes, pulleys, gears, racks, or other intervening mechanism."

It is added that "the floor trusses are proportioned for a live load of eighty pounds per square foot of floor and for two fifteen-ton trolley cars, and a wind-pressure of thirty pounds per square foot. The floor system is proportioned for a live load of one hundred pounds per square foot and for two fifteen-ton trolley cars. The counterweight cables are proportioned for a strain of 100,000 pounds, and the lower batter posts of the towers for 407,000 pounds each." The design is ingenious and well worked out, and furnishes a good study in the construction of this class of bridges.

The Harlem bridge is remarkable not only for its size, but because in it an attempt has been made to secure a more pleasing appearance by a modification of the standard American form of swing-span truss. The first impression made upon us by a look at this modification of form suggested at once the legend on the now familiar placard of a certain hook-and-eye manufacturer,—"See that hump?" The hump can not help being seen, and, we fear, will fail to compel admiration as an esthetic improvement upon swing draw-bridges. *Engineering News* says: "There may be some things in the field of engineering construction more awkwardly ugly

than the ordinary swing-span truss as usually constructed, but we do not now recall what they are. The attempt to remedy this by the introduction of curved outlines, which has been made in the present instance, is a most interesting experiment, and opinions will differ as to its success. We are inclined to believe that a more radical departure must be made from conventional forms, if the swing span is to be made a thing of beauty."

Another notable feature in this bridge is the employment of multiple-intersection lattice trusses for a bridge of this size, which, our contemporary says, "with the curved top chord," "have made necessary great care and accuracy in the shop and field work."

The structure is now complete, and, as soon as the approaches are finished, will be opened for traffic. This traffic not only is large at present, but is rapidly increasing. The swing-span must, therefore, be rapidly worked. This span is three hundred feet long and eighty-seven feet six inches wide, and it weighs 2,500 tons. The design is to swing this immense mass open or shut in two minutes. The span is supported on a turn-table sixty feet in diameter, running on eighty twenty-four-inch wheels. The movement is so easy that the span can be worked by hand power, but, in order to work it in the time specified, two fifty-h. p. steam engines are employed, either of which is sufficient to work the bridge. In case anything should necessitate the stoppage of the engine in use, the one in reserve may be at once put into service. Two boilers, each of sixty h. p., are to be installed, only one of which will be required, the other being held in reserve.

There are other interesting details of this bridge, but we pass them, our purpose having been served in calling attention to the important place now held by bridge-building as a branch of civil engineering, to the ingenuity displayed in meeting special requirements as they arise for different sets of conditions, and to the illustration of these points afforded by the articles we have thus briefly reviewed.

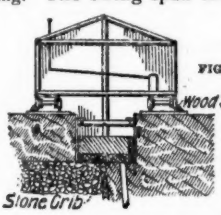


FIG. 1.

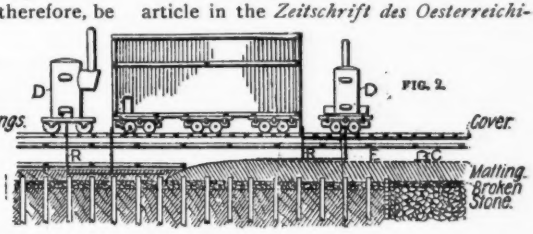


FIG. 2.

Concrete Work in Cold Weather.

THE construction of concrete work, or the use of cement and mortar in winter weather, even of the severest sort, has become so common under the intensified building methods of recent years that the practice is no longer regarded with distrust, and indeed hardly excites more than a passing interest; but the details of some work recently executed at Helsingfors, Finland, are unique, and warrant the attention given them in the *Engineering Record*, which presents an abstract from an article in the *Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines*.

The work was performed during the winter of 1895, and consisted in constructing foundations for a warehouse and two railroad-bridge piers. The necessity of completing the work in time for the rather brief summer season of maritime navigation induced the prosecution of operations during the winter, although the temperature ranged between 14° above and 40° below zero, F.

The foundation of the warehouse, in which the protection from weather was most essential, rested partly on the stone crib-work of an old quay and partly on piling, concrete being used to distribute the pressure. It had a depth of 31 inches and a breadth of 46 inches. "As this work was begun in early February," says the *Engineering Record*, "with the thermometer 4° below zero, F., especial care was

needed in the preparation, placing, and protection of the concrete until set. For this purpose a movable house, heated by two coke stoves, was mounted on wheels over the trench. This house was about 26 feet long and 20 feet wide, and was mounted on six four-wheel trucks. (See Figs. 1 and 2.) In this house, during the mixing of the concrete, the temperature was kept at about 54° F. The stone and sand were brought into the house in as large quantities as possible, and warmed before using. When mixed, the concrete was placed in the trench through the three trap-doors in the floor of the houses. These are indicated in Fig. 2, which shows the elevation of the house. To keep the outer air from the trench, the walls of the house were continued down to the ground by movable weather shields, whose edges were packed with coarse matting and wood shavings. As the ground water standing in the trench before the house moved up was always frozen hard and the ice between the piles was very difficult to chop out, steam boilers, mounted on wheels, as shown in the figures, were utilized to thaw out the ice and soften the ground by means of the steam pipe, R. When the ground under the house and a little in advance had been thawed out, a twelve-inch layer of broken stone was packed in. The concrete was mixed by hand, with the water warmed to between 158° and 176° F. The proportions of the bulk of this were 1:5:6, and of the upper layer 1:3:5.

"To protect the concrete until set against the entrance of frost from the sides of the trench, sheet piling with a filling of broken stone was used, as shown in Fig. 1.

"As soon as placed, the bed thus prepared was covered with a double layer of straw matting, and the whole trench-space given a covering of plank, matting, and trodden snow. The house was then moved on, and the space left, as shown at E, in Fig. 2, warmed by the kettle, C, filled with burning coke. This kept the temperature of the air at about 54° F., and insured the setting of the concrete in warm water. The value of the precaution was shown at one corner of the building, where the concrete was badly damaged by an exposure to the air one night at a temperature of 20° F. The rest of the concrete hardened inside of two days, and eight days after the construction of the upper masonry was in progress."

The Influence of Sand-Grains in Cement Mortars.

A SUGGESTIVE field for study and investigation is opened by a paper on the effect of the granulometric composition of sand upon cement mortars made from it, prepared by M. R. Feret, chief of the Laboratoire des Ponts et Chaussées at Boulogne, and reproduced by the *Engineering Record* from a translation by Capt. O. M. Carter and Assistant Engineer E. A. Geiselr, U. S. A.

The paper, which, unfortunately, is not very clear in translation, is chiefly a suggestion of the scheme of tests to be followed out in determining the suitability of any given sand, or of deciding between two or more alternative sources of supply; for, according to M. Feret, the problem has so many variables that "sufficient information," in any special case, "can be obtained only by the study *a posteriori* of a series of test-mortars obtained by combining in different proportions the sand and cement considered."

	250-Kilogram Mortars.	500 Kilogram Mortars.
Volume of mortar furnished by 1 cubic meter of sand (yield).	From 0.940 to 1.030 m^3.	From 0.970 to 1.180 m^3.
Weight of cement entering into 1 cubic meter of mortar.....	From 243 to 266 kg.	From 424 to 516 kg.
Absolute volume of solid materials entering into the unit of volume of the mortar $(c+s)$...	From 0.570 to 0.737.	From 0.565 to 0.728
Volume of voids remaining in the unit of volume after drying (porosity)...	From 0.145 to 0.330.	From 0.093 to 0.210.
Decomposition by salt water after one year's continuous immersion	All degrees, including total absence of disintegration.	No disintegration.
Resistance to compression per square centimeter after one year's immersion in fresh water	From 35 to 130 kg.	From 100 to 200 kg.

To enforce this conclusion, M. Feret presents a table showing the wide range of results, under various tests, obtained from various samples of mortar which differed one from another only in the sizing of the sand grains. The table is thus introduced:

"It has been shown that, in whatever manner sand is measured,—by weight or by volume,—the ratio of the resistances of mortars obtained by combining the same weight of cements with sands mineralogically identical may vary from one to three, according to the proportion of the different sizes of grains contained in those sands. The other properties of mortars—permeability, decomposition by salt water, etc.—depend almost entirely on the granulometric composition of the sand.

"The most important test to which sand should be submitted will then consist in measuring the proportion of grains of each size which it contains.

"It is proposed to call pebbles all grains remaining on a plate perforated with circular holes 5 millimeters in diameter, and to divide the pure sand into three sizes defined according to the diameters in millimeters of the circular holes in perforated plates serving to separate them.

"Large grains (G): pass 5 millimeters; remain on 2 millimeters.

"Medium grains (M): pass 2 millimeters; remain on 0.5 millimeter.

"Fine grains (F): pass 0.5 millimeters.

"The proportions of those three classes of grains expressed in hundredths of the weight of pure sand will make known the granulometric composition of the sand. The proportion of pebbles expressed as a function of the weight of pure sand will also be indicated.

"Numerous experiments made on mortars of mixtures of 250 and 500 kilograms of the same cement to the cubic meter of sands of the same nature (ground quartz), differing only in their granulometric composition and measured always in a dry state in the same manner, have shown, as can be seen by the examination of the table below, that mortars of the same proportions can have very different properties.

"Hence it is evident that an indication of the proportion or composition of any mortar suitable for employment in any given work has no signification when the sand is not defined, and that, according to the sand which is used, the proportion of cement to be combined with it must vary. It is important that there should be determined for each sand the proportion-mixture to which any given quality of mortar corresponds."

The Regularization of the Danube.

ONE of the most important engineering events that has recently occurred is the formal opening of the Iron Gates of the Danube, which took place September 27, the occasion supplying the text for an able editorial review of the present status of the work in *Engineering* (Oct. 2). It is, perhaps, a too frequent incongruity in great enterprises that their formal opening is not always an indication of the completion of the work. Particularly has this been the case in the history of great canals and artificial waterways. So, in this work of removing the obstructions to navigation from the bed of the Danube, and the opening of the river through the so-called Iron Gates, the completion is still deferred, though the channel has been improved sufficiently to permit the passage of vessels through sixty-five miles of the course hitherto practically unnavigable. An open channel of six feet and seven inches of water throughout the entire year has thus been supplied between the upper and lower channels.

In *Engineering* (June 9, 1893) the history of ancient and modern works directed to improvement of navigation in the Danube, and of the numerous schemes for proposed improvement, was presented.

The work has been a large and expensive undertaking, involving the removal of 258,500 cubic meters of rock from under water, and 362,500 cubic meters of other rock. About 783,000 cubic meters of rock have been laid into dams and walls. The rubble shot was about 258,000 cubic meters.

The difficulties encountered have been greater than was anticipated. The blast-

ing has been on an unprecedented scale for this class of work. A maximum charge of 26,000 pounds of dynamite was used on one occasion, but other very large charges were used at times, and with great effect. Blasting with large charges of powerful explosives has been made a study by able engineers, and will doubtless be more practised hereafter.

On the cutting of channels under water *Engineering* says that "many experiments had to be made before the cutting proceeded satisfactorily. Most of the appliances suggested were quite impracticable." Dynamite cartridges dropped into the bed of the river upon the rock gave satisfaction only in disposing of loose stones; massive rock was little affected by them. It soon became apparent that drilling and subsequent blasting can be recommended only for depths of more than twenty inches, and that, for very uneven bottoms and excavations of lesser thickness, the rock-crushers, first applied in the Suez canal, answer best. Of the drilling-machines it is pleasant to note that the Ingersoll rock-drill (American) is named as among the best working appliances.

Many valuable data upon the action of explosives have been gained; and, generally, it may be said that the execution of every large work like this leaves the engineering profession better equipped for carrying out any similar work in the future.

The Water-Revenue of a Nation.

MR. C. E. DE RANCE, of her majesty's geological survey, makes some very interesting and important suggestions in a paper on "Hydro-Geology and Hygiene," originally read before the British Association of Water-Works Engineers and recently republished in *The Canadian Engineer*.

Mr. De Rance's illustration and application are, naturally, chiefly local; but the main line of his argument is even more forcible as applied to American conditions, for we have been singularly inattentive to the important branch of engineering study which constitutes his topic.

Sketching briefly the history of the line of observation upon which the further study of the subject rests, Mr. De Rance says:

"The term hydro-geology, to express the study of the passage of water when, as rainfall, dew, or snow, it reaches the surface of the ground, or percolates beneath it, appears to the writer to deserve more general acceptance than has been accorded to it. It appears to have first been used by a French Jesuit priest about half a century ago, and was adopted by Mr. Lucas in his studies on the chalk-water supply of the south of England twenty years since.

"A Lancashire squire, one of the Townleys of Townley, near Burnley, appears to have been the first to systematically observe the amount of rain falling more than two hundred years ago; a century later, in 1766, a rain gage was placed on the top of the square tower of Westminster Abbey by Dr. Heberden, F.R.S. Early in 1861 G. J. Symons, F.R.S., began his magnificent organization; his modest pamphlet of four pages of that year, with 168 observers, has now blossomed into a volume of 254 pages, with a staff of 3,043 observers. Looking to the bearing of the inquiry on manufacturing, engineering, agricultural pursuits, and the health of the inhabitants, it is remarkable that such an investigation should be left by the nation to the self-abnegation and industry of this remarkable voluntary effort. Mr. Symons's annual volume is a record of the nation's 'Water Revenue,' on which depends the amount available to be consumed by men and animals, to be absorbed by agricultural crops and forests, or utilized in manufacturing processes, purposes of inland navigation, the production of steam and electric energy, and the preservation of fisheries. From the amount recorded, large amounts have to be written off from several causes, which probably vary from year to year: (1) evaporation, which is governed by the comparative dryness or wetness of the air at the moment of the rainfall; (2) the amount percolating, which varies also according to the comparative dryness or wetness of the soil, in dry periods vegetation taking up a very large proportion,

and, indeed, after long periods of drought the whole of the volume percolating is so arrested, and none sinks to replenish the underground storage; and (3) lastly, there is loss from transit of percolation water into areas where the supply cannot be obtained by pumping. This is the case when the sectional area of a porous rock, where it dips and disappears beneath overlying impermeable material, is sufficient to discharge the water into outside areas,—*i.e.*, tidal rivers on the sea. Of the rainfall that is absorbed by the area of outcrop of the porous rock, nothing goes into the streams until rainfall additional to the amount that runs to waste causes the saturation level in the porous rocks to rise above the level of the V-shaped valleys which intersect it, and, in the case of dry valleys, a 'bourne,' or temporary stream appears."

The history of rainfall observation has a passing interest only; our own weather bureau has an admirably developed system for this part of the work, and exhaustive table of averages, maxima and minima, by sections and by seasons, from which almost any required data may be immediately obtained.

The point to which attention should be drawn is the study of the possibilities of utilizing or controlling the rain after it has fallen,—the treatment of the entire subject in the light of the conception strongly conveyed in a single phrase: "The Water Revenue of a Nation."

From this conception Mr. De Rance develops a suggestive system of control and utilization, based largely on English political organization and adaptable to American conditions only after radical remodification, but embracing as its four principal features (1) topographical and sub-surface examinations to determine the location and extent of potential water-supplies; (2) extensive and systematic observation of surface-flow in streams and rivers, with the collateral establishment of a flood-warning service; (3) stream-control by competent boards in the interest of the entire public; and (4) the establishment of storage reservoirs for the prevention of floods and the conservation of now-wasted flood-waters.

The second service is now being rendered by our water bureau to some extent at least; the fourth falls directly in line with the suggestion made in this magazine not long since in the article entitled "The Causes of Floods in Western Rivers."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

BRIDGES.

8717. **The Essex-Merrimac Bridge.** Horace C. Hovey (Describes what is known as the Essex-Merrimac bridge, crossing at Deer Island from Newburyport to Salisbury. It has existed in two different forms, each having a bearing on the general interests of bridge building). Sci Am.—Oct. 17. 1600 w.

8789. **The Design of Drawbridge Details** (Abstract from book by Charles H. Wright. The article is a clear presentation of the subject of plate-girder draw-spans and their machinery, and is well illustrated). Eng Rec—Oct. 17. Serial. 1st part. 2500 w.

*8854. **The Snodland Bridge Over the River Medway** (Illustrations and brief description of a unique design on a new line of bridge construction with arched steel tubes). Eng, Lond—Oct. 9. 400 w.

8884. **Building a Small Stone Highway Bridge** (Bridge designed by J. F. Fisher, of Chicago. Data of design and construction, with elevation). Eng Rec—Oct. 24. 1300 w.

9019. **The Newtown Creek Hydraulic Bascule Bridge** (Description of accepted design for a bascule bridge operated by hydraulic rams and counterweights for the crossing from Vernon to Manhattan avenues. Illustrated by diagrams). Eng Rec—Oct. 31. 450 w.

*9023. **London Bridge.** A. J. Glasspool (Historical review, mostly relating to the old London bridge). Arch, Lond—Oct. 23. 2200 w.

9093. **The Third Avenue Drawbridge Over the Harlem River, New York City** (Illustrated description of one of the largest and heaviest drawbridges ever built). Eng News—Nov. 5. 1000 w.

We supply copies of these articles. See introductory.

9094. The Newtown Creek Bridge Competition (Facts in connection with this much discussed piece of engineering work, with illustrated description of designs submitted). Eng News—Nov. 5. 5500 w.

9095. The Design of Movable Bridges (Editorial discussion of interesting questions in connection with this subject). Eng News—Nov. 5. 2500 w.

9100. The Erection of the Belle Isle Bridge (Illustrated description of bridge over the Detroit River, constructed to meet unusual conditions of soil and water). Eng Rec—Nov. 7. 700 w.

*9115. Fixed Girder Bridge Over Great Ducie Street, Manchester. J. Gilchrist (Description of a metal bridge under conditions made difficult by want of room for construction). Engng—Oct. 30. 3300 w.

CANALS, RIVERS AND HARBORS.

*8667. Harbor Improvements in Western Australia (The first part relates to the harbor of Fremantle mainly. The need of a harbor at this point is shown and the two schemes proposed for the improvement of the harbor are presented). Engng—Oct. 2. Serial. 1st part. 2000 w.

*8669. The Regularization of the Danube (Some historical particulars and features of the task, with account of the character of the work and difficulties encountered). Engng—Oct. 2. 4000 w.

*8672. The Iron Gates of the Danube (Illustrated description of this difficult work, now nearing completion). Eng, Lond—Oct. 2. 5300 w.

*8683. The Opening of the Iron Gates (Editorial on the removal of the obstructions to navigation in the Danube). Trans—Oct. 2. 1800 w.

*8684. Harbor Development in South Africa (General plan of East London Harbor, with account of improvements). Trans—Oct. 2. 2200 w.

8880. Improving New York's Canals (Report as to the nature of the work to be immediately undertaken. The worst portions of the Erie, Oswego and Champlain canals to be first improved). Sea—Oct. 22. 3000 w.

8938. Suspended Arch-Centers at the Port of Bordeaux (A novel feature of construction is illustrated and described. The work was done in building the new quays at the port of Bordeaux, France, and made necessary by the conditions and the character of the soil). Eng News—Oct. 22. 800 w.

8973. The Breakwater Extension at Buffalo, N. Y. (Illustrations taken from the Government specifications, showing the general construction of both the rubble and timber work, are given). Eng News—Oct. 29. 800 w.

9072. The Lake Biwa-Kioto Canal, Japan. Sakuro Tanabe (Illustrated description of a canal constructed with the objects of opening a line of boat navigation between the lake and Yodo River through Kioto, the production of water power and the distribution of power and light in the city by electricity, and the irrigation of rice fields in the vicinity). Sci Am—Nov. 7. 1400 w.

9073. Opening of the Danube to Navigation (From Illustrirte Zeitung. Illustrated historical account of this great engineering work). Sci Am Sup—Nov. 7. 3000 w.

†9092. The Discharge of the St. Lawrence River. C. H. McLeod (Investigations made by the students of McGill University under the direction of the writer and assistants. Illustrated by diagrams). Trans Can Soc of Civ Engs—June. 1800 w.

HYDRAULICS.

8791. The Gileppe Dam (Illustrated description of one of the great dams of the world). Eng Rec—Oct. 17. 600 w.

*8993. Uniform Flow in Open Channels. E. S. Bellasis (The paper proposes to supply information regarding the practical aspects of the subject, especially the laws which govern the action of a stream on its channel. Part first consists of preliminary remarks, definitions, &c.). Engng—Oct. 23. 2200 w.

†9091. The Storage of Water in Earthen Reservoirs. Samuel Fortier (Opinions expressed, suggestions offered and consideration of practical features relating to reservoir dams and the storage of water). Trans Can Soc of Civ Engs—Oct. 7400 w.

MISCELLANY.

*8758. Methods and Results of Stadia Surveying. F. B. Maltby (Notes on the practical use of the stadia as gained principally from the writer's own practice. Methods employed, with examples of results attained). Jour Assn of Eng Soc.—Sept. 10000 w.

8790. Construction of Concrete Foundations in Cold Weather. M. Strukel (Abstract from an article in the Zeitschrift des Oesterreichischen Ingenieur und Architakten-Vereines. Description of successful work accomplished with the thermometer between 14° above and 4° to 40° below zero). Eng Rec—Oct. 17. 1000 w.

*8857. Ore Shipping Piers on the Cantabrian Coast (Brief illustrated description of piers designed to meet special needs). Eng, Lond—Oct. 9. 700 w.

8937. Engineers and Speculative Enterprises (The "Code of Ethics" adopted by the Canadian Society of Civil Engineers—supplies the text for a strong editorial discourse deprecating the connection of engineers of good standing with enterprises of questionable character). Eng News—Oct. 22. 1400 w.

*9131. The Management and Position of Rural Roads (The system under which rural highways are managed in England). Builder—Oct. 31. 1700 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

The British Post-Office Tests of Incandescent Electric Lamps.

IN its practical bearing upon the future of electric lighting, Mr. W. H. Preece's paper read before the Mechanical Science Section of the British Association, describing official tests instituted and carried out by the British post-office, is of the very first importance. The extent to which the public has been imposed upon by the representations of manufacturers in the sale of lamps since the termination of the Edison-Swan patents is well shown by the results of these tests. *The Electrician* (Sept. 25), in its report of this paper, presents a series of eighteen diagrams on a large inset sheet, which afford the following data:

(*a*) Curves of candle power and life of the lamps of twenty-three prominent manufacturers.

(*b*) Efficiency curves.

(*c*) Curves of candle power of lamps of eight other manufacturers.

(*d*) Curves connecting time with candle-power (percentage) and watts per candle respectively, for lamps of initial watts per candle-power of three to four, of more than four, and of two to three; also for fourteen lamps of more than four watts per candle, of nineteen lamps of three to four watts per candle, and three lamps of from two to three watts per candle.

(*e*) Curves showing percentage of lamps replaced.

(*f*) Curves connecting cost per candle-hour and time for fourteen lamps—initial watts more than four, nineteen lamps—initial watts between three and four, and three lamps—initial watts between two and three.

This sufficiently displays the extent and nature of the investigation, and it is difficult to overestimate the value of the data furnished. Of the methods employed in these tests *The Electrician* regards as the most praiseworthy "the practical method by which Mr. Preece 'ages' a lamp. . . By stressing it for something like a couple of minutes to nearly twice its working pressure, he obtains some idea as to its quality and probable life.

"The post-office test for india-rubber is based upon an analogous principle, which has been recognized as a good one by the board of trade in their insistance upon stressing tests of an hour duration for central-station plant. Incandescent lamps may now be tested for: (*a*) efficiency; (*b*) life; (*c*) breaking-up pressure; (*d*) results after stressing to three-fourths of their mean breaking pressure. The latter two tests are comparatively novel, and seem for the first time to have been entered upon systematically.

"The life history of lamps—including, as it does, the results of a gradual deterioration in the light-giving filament—seems to establish a falling off of candle-power coincident with a rise in the watts per c.p. Some lamps, as has been shown by Prof. Ayrton, and corroborated by Mr. Preece, show an increase of candle-power at first, afterwards diminishing to the original value, and then falling below it. The average consumer requires a lamp that has a fairly flat c. p. curve until the filament gives way; otherwise, as time goes on, there are sure to be complaints about the supply. Of equal importance is the efficiency; this must be fair, or the cost of lighting is found to be a great objection; but high efficiency has, so far, not proved altogether a success. Mr. Preece says 'the so-called high-efficiency or economical lamps evidently suffered more than those of about 3¼ watts per candle' in the life tests. This corresponds with actual experience on a large scale, and we have frequently pointed out that the demand indicators on consumers' premises usually read as if a 16-c.p. 100-volt lamp took 0.6 to 0.66 ampere, while the 8-c.p. lamp gives

nearly 10 c.p. on the average, and certainly is not overrated if taken as a 35-watt lamp. Mr. Preece's figures for current show a rather better result in this respect.

"The breaking-down test and stressing test will probably be largely used by lamp-buyers in time to come. Lamps of 100 volts put on a 200-volt circuit frequently go at once, so it is evident that the test requires care in its carrying out. Lamps of 16 c.p. run, say, in an engine room where the pressure is raised 10 per cent. above the normal at the time of heavy load, each evening, do not last very long, 100 to 150 hours being the average. On the other hand, the curious fact has been noticed that high candle-power lamps (such as 200 c.p. and 300 c.p.) last 700 or 800 hours under the same conditions, but with excessive blackening. What lamp-makers think is manifested by the statement in the recently-issued catalogue of the Ediswan Company that 'lamps marked 100 volts are not intended to be run systematically at 102 volts.' After all, the pressure variations on a London central-station circuit frequently amount to 4 or 5 volts every evening at points close to the generating stations or feeding centers, and lamps are bought to be used with the public supply as it is, not as it should be. The life of 3½ to 4 watts per c.p. lamps may be taken as twice that of high-efficiency lamps, and Mr. Preece's figures substantiate that, while 'a short life and a merry one' is a good adage, if not carried to extremes, we are yet without a satisfactory high-efficiency lamp."

There is an amusing phase of this important investigation which, if we wanted to be funny, we should call "The Drop Act." The performances of some lamps seem to justify this appellation. Rated at sixteen candle power, they started at from twelve to fourteen, and with celerity fell to lower efficiency. This drop in efficiency seems a general characteristic of incandescent lamps, but it varies largely in lamps of different make.

The *Journal of Gas Lighting* classifies the lamps with reference to this point as follows: "(1) Those that start at about their nominal candle power at a high efficiency, but very quickly show a decided falling off in candle power and efficiency, and become practically useless in 400 or 500 hours; (2) those that start off at about their nominal candle power, give a useful light for about 1,000 hours, and then burn out; (3) those that start off like those in the second class, but do not break; and (4) those that start off with a candle power below their nominal value, and keep it up fairly steadily, for 2,000 hours or more. The two middle classes are apparently the most promising lamps for practical service; but the difficulty is to identify them quickly and reliably."

The consumers of incandescent lamps may congratulate themselves upon the investigation and the published results, which will no doubt have a beneficial effect upon the framing of specifications henceforward. The fact that the names of the different makers of the lamps tested are given with the results of the tests adds much to the value of the report to the general public.

The Potential of Steam.

THE substantive term "potential" has been used in a variety of ways. It fundamentally means a possibility. One of its most common uses is found in electricity, wherein it indicates the capacity for work in an electric current at any point in a circuit; but this is by no means an exclusive use of the word, as any one may see by consulting a good modern dictionary.

As good writers on electricity have, moreover, already admitted that "'capacity for doing work' and 'potential' are convertible terms,"* without any restriction as to the mode of energy which manifests the potential, we scarcely understand how it can be said that the term has been "monopolized by electricians." Such, however, is the allegation of a Royal Hibernian Academician, put forth in a paper read before the Institution of Civil Engineers, Ireland, the first part of which is published in *The Electrical Review* (London, Oct. 16). We agree with the author of this paper, Mr. Howard Pentland, that

*Slingo and Brooker, "Electrical Engineering," page 6.

the term "potential" may be appropriately and usefully employed more frequently in discussions of work derived, or possibly to be derived, from any source of energy, including steam; but we hardly think he is right in his charge of monopoly. At the same time we heartily approve his proposition to employ a uniform nomenclature for steam and electricity, and the lines he marks out on which the approach to uniformity may be practically made. He says: "If we discuss with a central-station engineer the theory of the most advanced form of steam dynamo, say, a large Sayer's patent continuous current shunt wound machine, with an efficiency of about 95 per cent., driven directly by a Willans patent central valve compound engine, with an efficiency of about 90 per cent., giving a combined efficiency of about 85 per cent., it will be observed that he uses two languages, the foot-pound-second language on one side, and the centimeter-gram-second language on the other side, of the fly-wheel. Bring him to one end of the common bed plate, and he talks of horse-power, foot-pounds, pounds-per-square-inch, and British thermal units. Bring him to the other end, and he talks of watts, joules, volts, and calories."

"A constant stream of energy flows through the steam dynamo from the boiler. The energy of the coal is converted into the energy of the steam, the energy of the steam into the energy of the shaft, and the energy of the shaft into the energy of the electric current. Not only, however, does the unit of energy-measurement change at the last conversion, but the very principle of measurement on which the unit is based. However desirable, therefore, may be the substitution of the centimeter and the gram for the foot and the pound,—a course I have no intention of now advocating, although the kilowatt is slowly but surely driving the horse-power out of the modern specification,—it leaves the main evil untouched. Energy, or the capability for work, is measured, in respect of quantity, on the same principle on both sides of the fly-wheel, but, in respect of degree, on three different principles! It stands to reason that, whether it be desirable to adopt the centimeter-gram-second system or not, it is, at all events, desirable to have a common principle of measurement throughout, not alone for the energy which goes in through the furnace door or the steam port and comes out through the brushes, but for its *degree or potential*."

Now this is sound, common-sense talk. As well might we have one set of units for measuring length, girth, and weight of live oxen and another for dressed beef as separate sets for the same thing in steam and electric engineering.

Mr. Pentland says:

"The potential of both coal and saturated steam is now estimated in British thermal units per pound, the potential of the expanding steam in pounds-per-square-inch, and the potential of the electricity in volts—in fact, by heat pressure and *work*. Why not by *work* throughout? . . . The sooner steam users awake to the fact that the idea of potential is a general conception which is no more concerned with electricity than with steam, water, coal, the luminiferous ether, dynamite, beef, or any other substance whose energy, temporary or constant, ministers to our needs, the clearer will be their mental vision, and the less their mental labor in the domain of energy, work, and power. For many years men have reasoned about the pressures of water, steam, and air, the level of lakes, the run of clock weights, the loudness of notes and noises, the temperature of gases, the candle-power of lamps, and the velocities of projectiles, and they have recognized that, although these things require distinct measurement by foot rules, gages, thermometers, photometers, phonometers, ballistic pendulums, and the like, they are manifestations of the one thing whose common measure is work,—namely, energy, or the capability for work. But, while they have recognized this, they have failed to see that, although steam and electricity are incommensurable in respect of quantity, the degree of energy or potential which they possess may be measured, if not by the same unit, by a unit based on the same principle, which in each case shall bear

the same relation to the unit of quantity as specific gravity to weight, or specific heat to total heat."

The author then defines "potential" as "specific energy," or specific capability for work, or the capability of the unit quantity for work. He then argues that the possibility exists for expressing the qualities of the energy of steam in the same terms as are used for expressing the qualities of an electric current.

"It is an extraordinary fact that, although work per unit is the true measure of potential, there are no less than seven measures and *quasi* measures of potential in use,—namely, (1) *height or level* in feet, as in the case of water or clock-weights; (2) *pressure* in pounds-per-square-inch, as in the case of water, air, or steam; (3) *quantity of heat* in British thermal units, or in calories, as in the case of fuels or saturated steam; (4) *temperature*, as sometimes in the case of steam in degrees F. or C.; (5) *mechanical work* in foot-pounds or in joules, as in the expansive use of steam; (6) *electrical potential* in volts, in the case of electrical currents and condenser charges; and (7) *lucic intensity* in luxes, in the case of light. No one, however, has as yet attempted to measure sound potential; so we are probably delivered from an eighth!"

It is also maintained that, whenever work is done, there is, as matter of fact, an actual circuit set up, as much with steam and other forms in which energy is manifested as with electricity. Any one accustomed to think much upon natural methods and operations must concede this. Whenever work is done, something is taken temporarily from a general stock, to which it immediately returns after its service is performed. If it appear that something new has come into existence, we can make sure that in substance it is merely part of the stock from which we drew now diverted to some special function, distinguishable as an individual thing only till that function has been satisfied. Then it will go back into the general stock and complete its circuit, precisely as an electric current goes to earth and flows into the vast electric reservoir of our globe.

It is for these reasons that "the ideas of energy, work, and power which have proved so useful in the electric current seem to be equally applicable to steam or any other material current wherein potential runs through a cycle of changes."

Gas versus Electricity Direct from Coal.

MR. D. M. DUNNING, in his paper in THE ENGINEERING MAGAZINE for September, seems to have gained attention to his views in publications devoted to the interests of electricity, as well as in those published in the interests of the gas industry. *The Electrician* (London) antagonizes Mr. Dunning, taking issue with his proposition that, "if the direct production of electricity from coal were realized, . . . the electrician would only stand in this respect where the gas manager stands to-day," the latter producing energy direct from coal. To this and other criticisms made by the *Electrician*, the *Journal of Gas Lighting* replies editorially with so much force and pertinence that we cannot refrain from quoting the principal arguments in its well-written article (Sept. 22) entitled "A Fallacy Exposed." *The Electrician* said of Mr. Dunning's proposition, above quoted, that "we are constantly being reminded of those wonderful bye-products with the aid of which gas companies, if they had a mind to, could give their gas away without money and without price."

Whereupon *The Journal of Gas Lighting* replies that Mr. Dunning's remark is "so obviously true,—seeing that the cost of fuel in generating electricity, even by the present uneconomical method, forms so small a part of the total cost of the central-station unit,"—that it is rather surprising "to find *The Electrician* falling foul of Mr. Dunning for stating the fact," even to the extent of calling the idea underlying the erroneous statement of the critic "an ancient bogey." The *Journal of Gas Lighting* goes on to say that, "as a matter of fact, of course, not a single gas company has ever pretended that the return from residuals can enable gas to be supplied *gratis*. This is the popular misconception of the state of things created by the circumstance that some gas under-

takings actually do pay for their coal, and all of them defray a substantial proportion of their coal bill, by means of the residuals of gas manufacture. It should not be necessary to inform an engineer, however, even if he happens also to be an electrician, that there are manufacturing industries in which the net cost of the raw material forms only a small part of the total working expenses. It is so to some extent in gas manufacture, at any rate; and, it is very much more so in electric lighting."

Mr. Dunning said that even a carbon battery of 100 per cent. efficiency "would place electricity in no more favorable position with respect to gas-lighting than is held by the steam-and-dynamo stations of the present day." This the *Electrician* calls "palpably absurd," while *The Journal of Gas Lighting* says "that, so far from being absurd, . . . it is the merest commonplace," and the reason why *The Electrician* does not so see it, is that "modern steam-and-dynamo stations have an energy efficiency of not more than from 7 to 10 per cent., at their best load, and a considerably lower efficiency on the yearly average." It adds "that the corresponding truth is entirely overlooked that the whole cost of generating the unit by these inefficient machines bears no greater ratio to the commercial expenses of carrying on the electric-lighting business, if, indeed, it is so much." It therefore charges that Mr. Dunning's critic, "in thus confounding the independent matters of physical and commercial efficiencies, is lending countenance to the mischievous delusion that electric-lighting can be materially cheapened by getting the necessary steam for nothing, by the aid of refuse destructors. If it would not, could not, materially reduce the cost of the central-station unit of electricity, were the steam procurable for nothing, what difference could it make if the machinery were to be replaced by a battery yielding the electricity direct from carbon?"

"To give the dream of a carbon battery every advantage, our contemporary assumes that, if such a process of generating electricity were realized, 'the energy efficiency of an electric station could be raised tenfold, and its capital outlay and yearly expenses be enormously diminished.' Even if the former result were achieved, would the latter necessarily follow? Carbon-oxidizing batteries would cost something to begin with, and they would need housing and looking after, just as steam machinery does; and all the other expenses of carrying on the electric-lighting business—the distribution, the management, the administration—would be unaffected by any change in the method of generating. . . . The existing electric-lighting undertakings, at any rate, would not benefit much by the introduction of a new patent carbon-oxidizing battery of ideal efficiency."

Now, all of this may or may not be viewed as extreme on both sides. We are inclined so to regard it. The ideal carbon battery would work its revolution in other fields than electric lighting. Doubtless the cost of the latter would not be so much reduced as at first sight might seem possible, but that some material reduction would result can not, we think, be doubted. *The Journal of Gas Lighting* admits that some items, in the nature of fixed charges, would remain the same. This being the case, their percentage of the entire output would become smaller with increase of output. However the subject be regarded, Mr. Dunning may congratulate himself that his paper has not failed to produce an impression.

Insurance of Electric-Lighting Stations.

IN this department for November we had something to say upon the subject of insurance for electrical plants. A large increase in insurance rates is now made the subject of considerable complaint in England, and has called forth an editorial protest from the *Electrician* (Oct. 30). This protest asserts that the advance in rates has aroused general indignation in the electrical fraternity, and that it is difficult to find any "justification for this augmentation of the burdens laid upon the shoulders of those engaged in the none-too-easy task of selling electrical energy at a profit." It asserts that the "small

percentage of serious disasters has been confined to works fitted up during the pioneering days, when wood was regarded as the safest insulator."

A cause of complaint is also found in the treatment of electrical constructors by the surveyors of the fire offices.

"These surveyors are now not only experts in fire risks, but possess considerable knowledge of the technical details of electric-supply works. They frequently recommend alterations in fixtures or improvements in construction which may reduce fire risks; but, no matter what the cost of these alterations may be, the premium is not reduced,—occasionally it is even increased. Works recently fitted up with every improvement in design and construction, so as to render a serious fire absolutely impossible, are compelled to pay excessive premiums even on the full value of buildings and every item of plant. In vain are enormous sums expended on imposing-looking Clapham-Junction-like switchboards of enamelled slate or marble, secured on iron framing, or built in walls surrounded neither by wood nor any other inflammable material; the floor may be of stone or cement, free from culverts or conduits for mains, which may all be enclosed in iron pipes; the roof may be constructed with iron principals and purlins, and with neither roofing felt nor timber of any kind. all these precautions have been taken, yet nothing can save the insured from the exorbitant charges of the fire offices. The committee of the fire offices is, in fact, all powerful, and it is difficult to believe that the offices are in any way influenced by the reports of the surveyors, since these gentlemen cannot possibly be ignorant of the value of their own improvements. The electrical industry has good cause for complaint. Years of hard work have resulted in the successful utilization of capital; and it seems strange that the industry which has removed gas, paraffin lamps, and candles from a large percentage of houses insured should now be the sport of those who might reasonably be expected to give it every encouragement."

It is impossible not to recognize the force of this protest; but it seems that, unless an insurance trust has been formed in England which prevents its action, the general law of competition should soon put an end to the exaction of extortionate rates upon buildings which conform in all respects to underwriters' requirements. A properly-built, properly-arranged, and properly-managed electric-lighting station is not of necessity an extra-hazardous risk.

Small Block Stations versus Large Central Electric Stations.

ONE of the questions now before the electrical fraternity has come out of the progress made in the construction and operation of gas engines. It having been satisfactorily demonstrated that electric lighting can be successfully carried out with power derived from gas engines, it has come to be considered a possibility that smaller central stations, each supplying a comparatively small district, may prove more economical than the large installations now driven by steam power. In a recent number of *Dingler's Polytechnic Journal*, the affirmative of this question was ably argued by R. Knocke. *Progressive Age* (Oct. 15), in a number devoted almost wholly to gas and gas engines, makes liberal extracts from Herr Knocke's argument, which show that the affirmative side has many reasons to offer in favor of the smaller installations.

Of course, the whole matter simmers down to cost estimates and profits on capital invested. It is shown that the large installations yield a good income only when they supply from the outset a large number of consumers. Often, after the first two years, the income, which through installations has been fairly good, falls off, and it may be several years before a sufficient increase of consumption brings the income up to a satisfactory return.

The constant increase in number is attributed to the rapid improvement of gas engines, which have made the production of power from gas very economical. The case of two thirty-five-horse-power engines built by the firm of Gebrüder Körting of Körhugsdorf, near Hanover, and placed in a block station in Frankfort-on-Main, is cited as in point. These en-

gines are of the single-cylinder type. The department of electrical tests determined the gas-consumption per horse-power hour to be an average of 17.52 cubic feet. The gas was taken from English gas works, and its mean calorific value was 565.5 B. T. U. per cubic foot.

Assuming that this measure of economy is attainable in any block station, and may be used in calculations of the power of gas engines, Herr Knocke proceeds to calculate the cost of an installation wherein the conditions obviate the necessity of a special system of feed-wires, and presents a detailed description of it. The figures of cost show a marked economy as compared with steam-driven installations. In conclusion the argument is summed up as follows:

"There have lately been many, in position to judge, who have predicted a great future for electric plants using gas-engines; Professor Slaby among others, whose authority is unquestioned, considers the use of gas-driven dynamos a most happy idea. These electric plants with gas engines present, moreover, the advantage of occupying but little space, and, furthermore, their efficiency is greater on account of the doing away with belts, and, finally, the reliability in working is greater on account of the direct coupling and the small circumferential speed of the armatures. The minimum cost of installation and operation, the simplicity of service, the avoidance of feed-water pipes and coal storage constitute still further advantages in favor of the plants; and, in short, the possibility of being ready for any emergency plays an exceedingly important *rôle*, taking into consideration the wide limits between which the demands of lighting vary. An installation supplied with gas-engines can meet easily any emergency, which is not the case with those using steam.

"Cities in which there is not as yet a central station, and, above all, those in which the gas works is operated by the municipality, have every reason for installing small 'block stations' with gas engines rather than large central stations with steam. As we have demonstrated above, these plants give a good income when the gas works is a private enterprise, and when gas can be purchased at net cost. Not only do these stations aid in the operation of the gas works, whose production they increase, and whose operation they render more regular, but the cities themselves are assured of a lasting income by the same utilization of the gas by means of the sale of the electric light. Through the competition of electricity, gas works are to-day working under greater disadvantages than formerly, since they are working on new paths in the introduction of heating and cooking by gas. The way that we are preparing in the preceding study will have, if it is engaged in, the advantage of conciliating opposite interests of gas and electricity; the interests of cities are also engaged, as, by the means that we have advocated, their gas works are assured of a good income, while responding to the present demand for electric lighting."

Two-way Tumbler Switch.

THIS device, recently brought out in London, is illustrated and described in *Engineering* (Aug. 21). Two-way switches are very convenient in many situations which will readily occur to electric engineers, and, for points where such a switch is wanted, the device here shown appears to have merit.

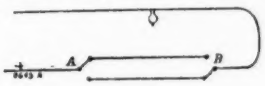


FIG. 1.

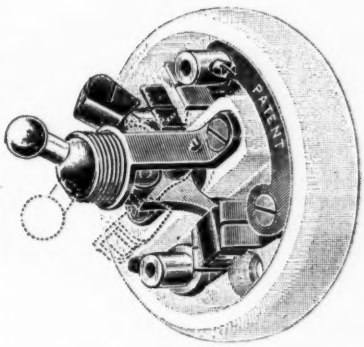


FIG. 2.

"In it a rigid metal rocker, furnished

with copper contact-pieces at each end, is pivoted between the usual uprights of a tumbler switch. The rocker is acted upon above by a vulcanized fiber roller in connection with the handle knob, and below by a powerful spring. Movement of the handle reverses the position of the rocker, allowing the current to pass into one or other of two circuits. One of the chief features of the switch is the exceedingly long break."

Two-way switches are useful whenever it is desirable to light or extinguish a lamp from either of two points,—say in halls, corridors, or bedrooms.

In diagram, Fig. 1, *A* and *B* are the switches, which may of course be placed where most convenient.

MR. HENRY S. CARHART (*The Electrical World*, Nov. 14), writing upon this subject, notices and criticises two articles that have recently appeared, one by Professor Ayrton and Mr. Cooper on "The Variations in E. M. F. of Clark Cells with Temperature," and another by Mr. W. Hibbert in the London Electrician on "A One-Volt Standard Cell." Professor Ayrton and Mr. Cooper, say "it has long been suspected that the lag of the E. M. F. of a Clark cell behind the temperature was due, not merely to the mean temperature of the cell itself lagging behind that of the bath, but to time necessary for the variations of the amount of crystals in solution, and for diffusion to take place." Mr. Carhart says that the use of the word "suspected" in this connection ignores much that has been written upon the subject, citing an article written by himself and printed in the *American Journal of Science* in July, 1893, as proof of his allegation. He asserts that a full volt standard has been *in esse* since the date named.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

LIGHTING.

*8681 Facts about the Electric Light. A. G. New and A. J. Mayne (The object of the paper is to place before readers, in simple language, a few leading facts about electricity as applied to the requirements of everyday life in order to remove the impression of danger, mystery and enormous cost). Ill Car & Build—Oct. 2. 2400 w.

*8689. Tests Made by Messrs. Korting and Mathiesen, Leutzsch-Leipzig, on the "Jandus" Arc Lamp (Light measurements which turned out very unfavorably to the "Jandus" lamp. Results given). Elec Rev, Lond—Oct. 2. 1600 w.

*8693. The Bristol Central Electric Lighting Station. J. R. Blaikie (Description dealing with the principles as compared with other electric lighting stations, drawing attention to characteristic features of the present plant). Elec Eng, Lond—Oct. 2. 2700 w.

8705. The New Congressional Library Building, Washington, and Its Lighting Plant. N. Monroe Hopkins (Brief illustrated description of this building with its substantial lighting plant). Elec Eng—Oct. 14. 1300 w.

8738. Termination of the Brush-Western Electric Double-Carbon Lamp Litigation (A victory for the Western Electric Co. Record of the case). W Elec—Oct. 17. 2200 w.

8775. Gas Engines in Central Electrical Stations. R. Knocke (Extracts from arguments as presented in "Polytechnic Journal of Dingler" favoring block stations with gas engines). Pro Age—Oct. 15. 3000 w.

8851. Incandescent and Arc Lamps for Electric Railway Circuits (Illustrated description of lamps adapted to railway circuits). Am Electn—Oct. 2200 w.

*8858. Working Alternators in Parallel at Hastings (A description of a successful switch used in working the Mordey alternators in parallel. The process explained). Eng, Lond—Oct. 9. 1800 w.

8965. The Luminous Fountain at the Millennium Exposition in Budapest, 1896. Josef Herzog (The origin of the project, how it was built, its special equipments and how it is operated). Elec Wld—Oct. 31. 2400 w.

8966. Electrical Effects in Political Parades (Illustrated description of luminous devices adapted for use in parades). Elec Wld—Oct. 31. 1900 w.

8974. The Moskowitz Independent System of Car Lighting by Electricity (Illustrated description of a system which seems to possess many practical advantages). Eng News—Oct. 29. 1200 w.

9085. Electricity at St. Elizabeth's United States Hospital for the Insane (Illustrated description of the uses made of electricity in this large institution). Elec Eng—Nov. 4. 2800 w.

*9134. Norwich Central Electric Lighting Station (Illustrated description). Elec Rev, Lond—Oct. 30. 2200 w.

We supply copies of these articles. See introductory.

*9144. Electric Lighting of Modern Office Buildings. William S. Monroe (The general principles of wiring are illustrated and explained and the advisability of making allowance for this branch of the building construction is presented). Arch Rec—Oct.-Dec. 3000 w.

POWER.

*8659. The Use of Electric Power in Small Units. Ill. William Elmer, jr. (A consideration of the conditions under which the employment of electric motors in small units may be advantageous to producer and consumer). Eng—Mar.-Nov. 4100 w.

8712. The New Station of the Long Island City Electric Illuminating and Power Company (Illustrated description). Elec Wld—Oct. 17. 600 w.

*8739. Alternate Current Station Switch Gear (Largely descriptive of an automatic non-return alternating switch designed by Leonard Andrews, of the Hastings Electric Light Co., Limited). Elec Rev, Lond—Oct. 9. 2300 w.

8746. Economic Use of Electric Power for Driving Tools. Reginald A. Fessenden (Read at the Sept. meeting of the Eng. Soc. of W. Penna. Things to be considered in arranging the system of power for a factory. Advantages of electric driving, cost, rate of production, &c., with general resume of results). Ir Tr Rev—Oct. 15. 3500 w.

8877. Direct Connected Engines for Electric Power Stations in Germany (Descriptions with illustrations of three engines recently installed in electric power stations in Germany. These will interest engineers in showing that the trend of practice in Germany is like that in America). Eng News—Oct. 15. 1500 w.

*8888. Designing a Bi-polar Drum Dynamo. Rankin Kennedy (Part first consists of statements preparatory to explaining and illustrating the processes generally used). Elec Rev, Lond—Oct. 16. Serial. 1st part. 700 w.

†8914. The Reconstruction of the Plant of the Chicago Board of Trade. Bion J. Arnold (Illustrated description of the general plan of the plant for producing light and power in building named). Trans Am Inst of Elec Engs—Aug. and Sept. 6000 w.

†8915. Present Status of the Transmission and Distribution of Electrical Energy. Louis Duncan (Full paper with discussion. Considers the different methods of transmission and distribution and the limits fixed by the present status of electrical development). Trans Am Inst of Elec Engs—Aug. and Sept. 12000 w.

8926. Electrical Devices for Changing the Speed of Series Motors. William Baxter, Jr. Showing how much variation in velocity is possible by the use of devices independent of the motor). Am Mach—Oct. 29. 1400 w.

*8944. Turbo-Electric Generators for Alkali Works (Illustration and description of one of two large generators constructed for the Electric Chemical Works of St. Helens, for the generation of electric current for the decomposition of salt into chlorine and caustic soda). Engng—Oct. 16. 500 w.

8955. Transmission of Niagara Power to Buffalo. Orrin E. Dunlap (Illustrated description of the construction of this line, now nearly completed). Elec Eng—Oct. 28. 2000 w.

9080. A New "Three-Wire" Dynamo. Alexander Rothert (Discussion of the new "three-wire" machine of the E. A. G., formerly W. Lahmeyer & Co., in Frankfort-on-the-Main). Elec Wld—Nov. 7. 1200 w.

TELEPHONY AND TELEGRAPHY.

8798. New Western Union Telegraph Offices at Buffalo. A. C. Terry (Illustrated description of the offices in the new Ellicott Square Building, which are considered among the finest in the United States). W Elec—Oct. 24. 1200 w.

*8823. Old Cable Stories Retold. F. C. Webb (A sketch of the laying of the Persian Gulf Cable of 1864). Electn—Oct. 9. 5000 w.

8852. American Telephone Practice. Kempster B. Miller (History and principles of the magneto telephone). Am Electn—Oct. 1800 w.

8866. Changes in the New York Telephone System (A review of the changes and the causes making it necessary to extend the capacity). Elec Eng—Oct. 21. 2000 w.

*8907. Thermostatic Fire Alarm Telegraphs. George Herbert Stockbridge (Illustrated description of automatic service). Elec, Lond—Oct. 9. Serial. 1st part. 1300 w.

*9028. Novel Application of the Loop Test. J. Rymer-Jones (Describes an expedient to meet a special emergency, of interest to electricians engaged in submarine repairs). Elec Rev, Lond—Oct. 28. 600 w.

9078. Experiments on the Theory of Telephonic Sound. Riugi Nakayama (Investigations from the point of electricity and from the point of acoustics—principally from the latter—and to find the requisites of a good transmitter). Elec Wld—Nov. 7. Serial. 1st part. 3200 w.

*9133. Veering Drums for Lightships (Illustrated description of invention of H. Benest for use in the problem of telegraphic communication with light ships). Elec Rev, Lond—Oct. 30. 900 w.

*9135. The Celebration of the Jubilee of the Electric Telegraph. M. J. Banneux (Address at the meeting of the Palais des Academies, in celebration of the establishment of the electric telegraph in Belgium. Historical Review). Elec Rev, Lond—Oct. 30. 4800 w.

MISCELLANY.

*8694. On a Complete Apparatus for the Study of the Properties of Electric Waves. Jagadis Chunder Bose (Illustrated description). Elec Eng, Lond—Oct. 2. 3000 w.

8706. Graphite from the Electric Furnace (Investigations of E. G. Acheson of the conditions under which graphite is formed in the carborundum furnace. Diagram is given with explanation). Elec Eng—Oct. 14. 1200 w.

8723. The Earth a Great Magnet. J. A. Fleming (Abstract of a lecture delivered to the workingmen of Liverpool on the occasion of the meeting of the British Assn in that city). Elec—Oct. 14. 1600 w.

*8744. Reostene; a New Resistance Metal. Dr. Harker and A. Davidson (Describes experiments made in a new alloy for commercial electrical resistances). Elec Eng, Lond—Oct. 9. 700 w.

*8745. The Division of an Alternating Current in Parallel Circuits with Mutual Induction. Frederick Bedell (Paper read before the British Assn at Liverpool. Mathematical, with diagrams). Elec Eng, Lond—Oct. 9. 1000 w.

8749. How to Check Station Instruments While on the Switchboard. A. O. Beneke (Directions, with precautions to be taken). Elec—Oct. 21. 1500 w.

*8822. On Criticism and on the Seat of E. M. F. in a Cell. Oliver Lodge (A criticism of Mr. Swinburne's second Canton lecture). Electn—Oct. 9. 1200 w.

8565. Charging for Electric Current on the Wright Demand System. How to Adjust Rates So that Every Class of Customer Shall Be Profitable to the Company. R. S. Hale (System explained). Elec Eng—Oct. 21. 2000 w.

*8889. On the Electrical Resistivity of Bismuth at the Temperature of Liquid Air. James De War and J. A. Fleming (Read before the Royal Soc. June 4, 1896. Describes experiments and gives results). Elec Rev, Lond—Oct. 16. 1000 w.

*8890. The Potential of Steam. Howard Pentland (A paper read before the Inst. of Civ. Engs., Ireland. The object is to show the electricians have no right to the exclusive use of the term "potential," and that it is a general conception concerned with all energy in whatsoever form it may be manifested). Elec Rev, Lond—Oct. 16. Serial. 1st part. 3000 w.

*8891. The Electrolytic Production of Potassium Percarbonate (Excerpt from account in Zeitschrift fur Elektrocheime to the effect that E. J. Coustam and A. von Hansen have succeeded in preparing a new salt of high theoretical interest). Electn—Oct. 16. 1500 w.

8964. On the Measurement of the Insulation Resistance of Street Railway Cables. Charles Hewitt (Describes a method of testing instituted by the author for the Electric Traction Co. of Philadelphia). Elec Wld—Oct. 31. 1300 w.

†8998. On the Induction Coefficients of Hard Steel Magnets. B. O. Peirce (A short account of the way in which deflecting magnets were made, with tables giving approximate knowledge of the induction coefficients of various makes). Am Jour of Sci—Nov. 2000 w.

*9027. Comparison and Reduction of Magnetic Observations (Report of a British Assn. Committee. Complete data as to the non-cyclic effects in the selected "quiet" days at Kew during the last six years). Electn—Oct. 23. 4400 w.

*9029. Apparatus for Eliminating Vibration from the Supports of Delicate Instruments (A statement of the principal features of an apparatus devised by W. H. Julius, of Amsterdam). Elec Rev, Lond—Oct. 23. 1000 w.

*9032. Lightning Conductors (A review of the present state of knowledge on this subject, with rules for the erection of conductors, which are said to be based on the highest scientific authority). Builder—Oct. 24. 4000 w.

†9043. On the Jacques Carbon Battery and on a Thermo-Tropic Battery (Discussion following experiments given by C. J. Reed at the meeting of the Electrical Section of the Franklin Inst.). Jour Fr Inst—Nov. 1200 w.

9059. Making Diamonds (An account of the address of M. Henri Moissau, delivered at the College of Physicians and Surgeons, New York, Oct. 27. Diamonds produced, quartz converted into vapor, and other remarkable results shown). Elec—Nov. 4. 2700 w.

9060. Modern Views of Electricity. Franz Dommerque (Abstract of a paper read before the Chicago Electrical Assn. Lines of work of various eminent electricians and theories advanced). Elec—Nov. 4. 1500 w.

9075. The Calibration of a Bridge Wire. W. M. Stine (Describes method, devised by the writer, aiming to give a simple, direct and accurate system). Elec Wld—Nov. 7. 700 w.

9079. Admittance and Impedance Loci. Frederick Bedell (A study of the relations arising from the reciprocal nature of admittance and impedance). Elec Wld—Nov. 7. 1300 w.

*9136. Contributions to the Theory of the Lead Accumulator (An account of rival theories of the reactions taking place in the ordinary lead accumulator). Electn—Oct. 30. 1200 w.

*9137. Dissipation Sheets and Wires (The behavior of a sheet or wire as an energy-dissipating apparatus is considered, but the article deals only with the care of sheets and wires of bare metal placed in a position such that equal radiation in all directions, and free but not forced connection, will carry away the heat energy). Electn—Oct. 30. 2100 w.

INDUSTRIAL SOCIOLOGY

Money and Prices.

THE leading article in *Gunton's Magazine* for November deals with what it calls a popular superstition, and holds that recent contention for free silver at the ratio of sixteen to one rests at bottom upon this superstition,—to wit, the belief that, "as government can fix the volume of money, it can also fix the price of commodities." Underlying the speeches of the free-silver presidential candidate, free-silver literature, and the platform of the Chicago convention is "the assumption that the value of all commodities is fixed by the volume of money." This is held to be "a remnant of the seventeenth-century doctrine that all prices or values are determined by the law of supply and demand." Of which doctrine it is affirmed that, "in proportion as economists have adopted inductive methods, this quantity theory has passed into decadence," together with "the old wages-fund theory," now also generally rejected by scientific economists, and "which was a part of this doctrine applied to wages." This doctrine, however, still retains its hold upon the popular mind.

Barker's "Bimetallism," recently published, justifies the assertions that this error is fundamental in the writings of free-silver advocates. It has been authoritatively declared that the struggle for free silver will be maintained; and, if this purpose be pursued, it will be fatal to the cause of sound money to permit any opportunity of resisting it to escape. Hence the argument against the propositions made on pages 17, 18, and 19 of Mr. Barker's book should be familiar to every one interested in the money question, which ought to mean every good American citizen. The propositions referred to are as follows.

"Commodities measure the price of money just as money measures the price of commodities. It follows of necessity that anything that causes money to appreciate must cause prices of commodities to fall, commodities measured in money becoming cheaper and money measured in commodities dearer. And so, inversely, anything that causes money to depreciate must cause prices to rise, for, the price of money in commodities falling, the price of commodities in money must rise." . . . .

"From the dawn of civilization down to 1873 . . . . prices have fallen and risen with a decreased and increased supply of gold and silver . . . . . But, when silver was discarded as a money metal, gold alone became the measure of value. . . . . To make exchanges at the old level of prices, both gold and silver were required. But, silver being cast aside, the burden was thrown on gold alone. . . . . The demand was limited to the power of men to command gold, and, as gold was twice as dear, twice as hard to get as before, prices fell one-half."

Of these statements *Gunton's Magazine* says: "They contain the key to the whole free-silver doctrine." Their plausibility is admitted, but they will not stand the test of inductive verification. It is also conceded that John Stuart Mill, in his "Principles of Political Economy," admitted this view, but under the restriction that the ultimate regulator of the value of money is cost of production.* The truth of the assertion that prices advance or fall with increase or diminution of the volume of money is then tested by facts of record, and a similar test is applied to the oft-repeated assertion that the demonetization of silver in 1873 reduced prices fifty per cent.

In this connection a table compiled from the Senate Committe Report (Vol. 1, p. 9), the Journal of Commerce Year Book for 1896 (p. 88), and Treasury Circular 123 (p. 52) is presented. For each year from 1860 to 1895 inclusive, this table gives "the volume of currency in circulation,

* "Principles of Political Economy," p. 29.

the per cent. of increase, the population, the money per capita, the general average of prices, and the value of paper currency in gold."

Now, this table very clearly shows that there was a steady increase in the volume of money in circulation from 1860 to 1892, while in the same interval prices dropped an average of eight per cent.

"If we take the period from 1860 to 1873, we find the volume of money increased 72.6, and the average price of commodities 37.5; in other words, prices only rose a little over half as much as the volume of money was increased. In the period from 1873 to 1879 the volume of money increased 15.4 per cent., and prices, instead of rising, as they should have, according to the quantity theory, fell nearly 41 per cent., and from 1879 to 1892 the volume of money rose 179.7 per cent., while prices, instead of rising in the same proportion, fell about 4 per cent. It will thus be seen that the movement of prices has sustained no regular relation whatever to the volume of money. On the contrary, in 1864, 1865, and 1866 prices were double what they were in 1860, and more than double what they were in 1891, though the volume of money in 1864-1866 was a third larger than in 1860, and only half as large as in 1891-1892. The price column in the table shows that the rise of prices began in 1862, and more than doubled by 1865, but the entire rise disappeared by 1879. Why did the rise in prices come and go between 1860 and 1879? It was not because of the increase in the volume of money, for that was much greater after 1879 than at any time before. It was, as everybody now knows, chiefly due to the depreciation of the greenbacks, and this was not governed by the increased volume, but by the public confidence in the government's ability to keep its promise and redeem its notes in gold. With every victory of the northern arms the value of the greenbacks rose, and fell with every defeat. The fall in prices that took place from 1865 to 1879 was not because the volume of legal currency had been diminished, for it had been greatly increased; but it was because specie payments were resumed. In other words, it was the quality and not the quantity that affected the prices. The movement in the value of confederate currency from 1862 to 1865 is cited as another illustration that prices do not rise and fall with the volume of currency." Its value fell as the probability of success to southern arms declined.

Now, as to the assumption that "the act of 1873 cast silver aside and threw all the burden on gold," or "struck down half the money of the world," it is denied that any such thing occurred.

"The act of 1873 did not even stop the use of silver, to say nothing of striking it from circulation. Down to 1873, we had no silver currency. Nobody would take any silver to be coined, because it paid them better to sell it as bullion in the market, as it was worth nearly three per cent. more as bullion than as coin. We have now nearly five hundred millions of silver money in circulation doing the same kind of work as gold, all of which has been created since 1873. The second half of this proposition—namely, that 'prices were cut in two'—is a mere deduction from the assumption that half the money was struck down, neither of which has any foundation in fact. The only way any seeming case is made out on this point is by comparing the prices of 1873 and those of 1891 and 1892, which are the latest dates for which we have authentic facts. In doing this they make no mention of the fact that 1873 was about the middle of the inflation period and the prices quoted are greenback prices, and that the fall in prices from 1873 to 1879 was due to taking the inflation out of the greenbacks and establishing specie payments. The only legitimate period for comparison, therefore, is from 1879 to 1891, or from 1860-1861, before the greenback inflation began. In either case, by taking the general average of prices as expressed by the index numbers, which to the silverite is an infallible standard, instead of having fallen fifty per cent., as 'Coin' Harvey, Bryan, Barker, and others assert, prices have fallen less than ten per cent., and this, as we have already shown,

can be fully accounted for by the economic causes affecting the production of the different articles, and cannot be explained by any change in the value of money, since the variation in prices differs with almost every commodity, some going up, some down, some not moving at all."

How the Protective System is Regarded in England.

AN article on the "Future of English Labor," in *Gunton's Magazine* for *November*, quotes a number of British newspapers, as indicating a trend of public opinion in the United Kingdom toward the abandonment of the policy of free trade and the adoption of a protective policy instead. "The relative decline of British trade, and the growth of outside competition, which has even resulted in foreign manufactured articles being sent into and sold in England itself, have formed," says the article reviewed, "the subjects of a large amount of economic discussion during the past few months."

We think this statement hardly expresses the real cause of the economic discussion referred to. There never has been a time when foreign manufactured articles were not sold in English markets. If anything is proved in the history of the world, it is that protective tariffs do not exclude foreign trade, unless they are made prohibitive in character, in which case provision for government revenues by special taxation must be made. But England has lately suffered to an unprecedented extent the effects of competition in her iron, cotton, and wool interests,—the industries in which she has reigned supreme,—and her tin-plate manufacture has received so severe a blow in the establishment of the tin-plate industry in the United States that doubtless many British economists are coming to think that free trade has exhausted its benefits for the United Kingdom, and that protection would now be a wiser policy.

The *Bradford Argus* is quoted as saying that, "in spite of the fact that Mr. Bryan is definitely pledged to a policy of free trade, whilst Mr. McKinley is as definitely pledged to protection, the general feeling in this district is in favor of the return of the latter. Had anyone predicted four years ago that it would be possible for the Bradford worsted industry as a whole, depending as it does so largely for its prosperity on a free entry to American ports, to be found arrayed on the side of McKinley and high protection, there would have been reasonable ground to express doubts as to his sanity. But, impossible as such a change of sentiment would have appeared four years, or even a twelvemonth, ago, it has actually occurred. Bradford wishes no evil to the United States, and Bradfordians would prefer to see a perpetual reign of McKinleyism—especially the McKinleyism as interpreted by the recent letter of the Republican candidate and the recent declarations of Republican newspapers—rather than see a people united to this country by so many ties of blood, tradition, and commerce plunged into the whirlpool of national disaster and national disgrace, which would infallibly be its fate if the people were foolish enough to adopt the policy of Mr. Bryan,—a policy as impossible of realization as it is crude and shallow in the theories on which it is based. We may even go further than this, and say that Bradford manufacturers as a whole approve on principle of the McKinley policy, as it has been interpreted by its author and some of the leading journals attached to his cause. That principle, as recently explained, does not embody the imposition of prohibitive duties, but such a tariff as will place producers in America on a fair footing with their competitors here, having regard to the higher rate of pay which prevails for most descriptions of labor on the other side of the Atlantic. It is to be a duty which will handicap British manufacturers to the extent of destroying any advantage which they may possess through cheaper labor, but not such as will interfere with 'keen and healthy competition' between the native and the imported goods. McKinley also recognizes in full the principle of reciprocity. We not only fail to see any just argument which can be urged against a policy honestly carried out on these lines, but it is such a policy as has often

been advocated in these columns for the United Kingdom, and for the empire at large under the proposed imperial trade federation."

Bradford is one of the most important centers of the woolen and worsted industries. It is presumable that a paper published for and patronized chiefly by those interested in these industries voices the opinion of the majority of its readers.

Other papers—the *London Times*, for one—attribute the decay of British industries to the action of the trade unions. Among the industries so injured the glass manufacture is prominent. Firm after firm, it is alleged, is going out of business, while the country is flooded with continental glasswares. The *Pottery Gazette* confirms this, saying: "We do not hesitate to say that our British glass trade has been ruined by the action of the men's unions. . . . If it had not been for the blind policy of the men's societies, the pressed glass trade of the north of England would have found work for hundreds, where it now employs units. When our pressed-glass workers quarreled with their bread and cheese, orders for pressed goods went to Belgium and France, and they have gone there ever since. The bane of trade unionism, as far as the glass trade is concerned, has been the resolve of the leaders to keep up the rate of wages under all conditions. The object alike of employer and employed should be the retention of English industries in England herself. We have had instances of great national industries being lost to us by the attitude of the workers in them. Is the glass trade to be added to them?"

Upon all this the author of the article reviewed remarks: "It does not require much reading between the lines to get at the real meaning of this. True to her economic traditions, England's trade must be maintained, whatever becomes of her labor. When it comes to a conflict between the foreign market idea and the interests of home labor, the latter must give way. This is not the particular fault of English capitalists; it is a logical working-out of the inherent viciousness of the foreign market economic doctrine. In blind devotion to this theory the *Times* lays the blame for the present situation upon trade unionism and 'factory and educational legislation.' That is, the only logical remedy free trade has to offer is lower wages, longer hours, and restricted schooling for working children.

"England must be prepared for one of two things,—a readoption of protection, or a long and bitter struggle over the wages question, ending in a loss to her laboring class of a large part of all it has gained through years of joint sacrifice, agitation, and strenuous effort.

"What is true of England is equally true of the United States. Our wages are the highest in the world, and upon this basis our national prosperity rests. To secure the continuance of these conditions, the protective policy must be maintained."

Economic Aspects of Immigration.

FOR many years a constant influx of population differing in nearly all social respects from the native American population has been modifying the status of society and altering the conditions of labor in the United States. For many years no important protest against this immigration has been made. Tariffs intended to protect American industries have been imposed, and it has been claimed that these must maintain the wages of American workmen at a higher figure than can be paid for the same kinds of labor in Europe. At the same time hordes of immigrants have been permitted to supplant American workmen by the simple process of accepting lower wages. There is, however, now in progress a general awakening to the evils of unrestricted immigration, and definite and decisive action upon the subject cannot be much longer delayed. While a considerable part of the flow of foreign population to this country is of the least objectionable character, it cannot be successfully denied that the great and rapid increase of paupers, criminals, and tramps is due more to unrestricted immigration than to any other cause. The bulk of this influx, drawn from the lower and worst classes of society, brings with it ignorance, a dislike

to the enforcement of law and order, and an utter disregard of the customs and manners of the people into which it comes, squalidly and disagreeably, as a disturbing element. It begins at once its competition in the labor market, abjectly accepting almost any wages that will enable it to crowd out the workers already engaged, and thus rob them of their places and livelihood. It is this which, more than anything else, has rendered futile efforts on the part of American labor to improve its condition.

In discussing this question, Mr. John A. Roebling, in *Gunton's Magazine* for October, takes the ground that "the whole question of the desirability, from an economic standpoint, of further large immigration" reduces to the question "whether high wages for the laboring class" are or are not "an advantage to the nation as a whole." No one will deny that high wages are beneficial to the wage-earner. "When his income is increased, his whole life is broadened and elevated. . . . Civilization and a considerable income are inseparable."

"But some one may say: This is all very true, and very trite. Every one desires every one else to have a large income, the larger the better; but where is it to come from? Higher wages mean either higher prices to the outside public, or else the ruin of the employers. In either case one class is enriched at the expense of another. Even though profits are excessive, possibly entirely unjust in some cases, it would be simply suicidal to drive all of the capital and talent for industrial leadership out of the country by such a policy. It would speedily reduce us to barbarism.

"This is an honest objection. It will occur to every one who candidly examines the question in all its aspects, and it should be honestly met. The underlying postulate of the argument is that a workingman can make only just so much in one day, and, if he should receive higher wages for it, that same amount of work must thereby become more expensive to some one else, either the general public or the employer."

An examination into the truth or falsity of this postulate shows that the higher-paid workman, considered merely as a producing machine, is the cheaper machine when measured by productive capacity. From this it follows that "we cannot afford to pay low wages. We cannot afford to let unrestricted immigration keep them low. For the sake of our own people, for the sake of those foreigners who are already here and under the protection of our flag, we must restrict immigration. And, if we are to remedy all these evils, it must be, not a half-hearted restriction of a few paupers or criminals or insane, but a drastic restriction of seventy-five per cent. of all immigration, that will, for some time to come, keep out all whose standard of life, and therefore of wages, is below the average standard of the American people."

The author sees no permanent safeguard against periodical panics or industrial depressions except in a gradual and permanent increase of wages, which the unrestricted importation of pauper labor from abroad obstructs, and will obstruct so long as it is permitted. It is shown that increase of our industrial power as a nation can go on successfully without immigration. To those who "insist that this country was destined as an asylum for the oppressed of all nations," it is answered that "our first duty is to care for those who are already here and under our protection."

The Foreign Market Delusion.

GUNTON'S MAGAZINE for October disputes the proposition "that a nation's industrial greatness depends upon the extension of its foreign markets." This is called an *a priori* assumption, a "doctrine essentially false," a "theory borrowed from the Manchester economics of a half century ago," and one that "could never have been evolved from any independent study of American conditions." The general proposition is thus narrowed down to a consideration of its applicability to the United States; the negative side of the question is argued from this standpoint, and recent comparisons between the exports of the years ending July, 1895, and July, 1896, showing increases in our exports, and anticipating the benefits to re-

sult (as recently made in the *Boston Herald*), are held to have no significance, as the increase "is scarcely more than normal, while the grand totals are far below those reached under the operation of the McKinley tariff of 1890." The argument from this opening proceeds to a comparison between home and foreign markets in their effects upon general industrial prosperity.

"Home markets are not only economically superior to foreign, because of their influence in binding together in a common interest all the industrial forces of the nation, but from now on they are certain to become, more and more, the chief markets which the producers of any country can rely upon. The world-wide extension of the use of machinery is fast doing away with the notion that any one country must, or can, even, be a workshop for all the rest. England is beginning to find this out already, as home manufacture in the colonies develops, and German competition becomes more aggressive.

"Even if the question of the location of a market, at home or abroad, were of no importance, the matter of its size certainly is. When this aspect of the question is considered, the utter folly of such figures as the *Herald's* is apparent. The immensity of the American home market and the insignificance of our foreign trade by comparison are manifest, from whatever situation the subject is viewed."

In 1889 the foreign market took of American products of agriculture, mines, forests, and fisheries 17 per cent. of the amount required for home consumption, while of manufactured products it absorbed only 1.4 per cent. Of products of all sorts it took only 5.6 per cent. The writer of the article under review claims that practically the same conditions existed in 1870 and in 1880. The exports, for 1870, 1880, and 1890, of agricultural products were respectively 15, 25, and 22 per cent. of the home consumption, while of manufactured products they were for the same years respectively 1.6, 2.2, and 1.4 per cent.

Further statistics are given relating to wool, corn, wheat, and oats, for the years 1890-94, which, it is claimed, "emphasize the fact that the hope of American farmers in the future lies in the continued growth of our manufacturing population,—that is, the non-agricultural,"—and that there is absolutely no opening for the American farmer abroad. It is concluded that, as compared with the American home market, "no other field of operations is worth considering," and that the "foreign market policy," instead of "containing the hope of a national greatness, has in it all the elements of national calamity, especially when sought by means of any sacrifice of the home market."

Industrial Progress in Japan.

THAT the industrial development of Japan is considered of the highest importance to the far-sighted men who are guiding the ship of State is indicated by the appropriations made by the diet during its recent session, a summary of which is presented in *Engineering* (London, July 17). The following sums were voted.

"(1) Improvement of the existing government railways, 26,553,000 yen, the payment to be extended over six years. (2) Extension of the telephone system, 12,802,106 yen, the payment to be extended over seven years. (3) Construction of a railway in Hokkaido, 1,178,313 yen, the payment to be extended over two years. (4) Construction of an iron foundry, 4,095,793 yen, the payment to be extended over four years. (5) New marine telegraph cables, 536,877 yen, the payment to be extended over two years. (6) Purchase of arms and ammunition, 9,258,088 yen, the payment to be extended over six years. (7) Manufacture of arms for the army, 6,486,766 yen, the payment to be extended over four years. (8) Manufacture of arms for the navy, 33,751,062 yen, the payment to be extended over six years. (9) Construction of ships for the navy, 47,154,576 yen, the payment to be extended over seven years."

The seventh, eighth, and ninth appropriations were universally denounced by leading statesmen not in the government and by the press, not for their exorbitance, but for their insufficiency.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines Reviews and Engineering Journals—See Introductory.

*8657. The Industrial Effects of Financial Isolation. Logan G. McPherson (Showing the inconvenience and danger to international trade presented by varying standards of value). Eng Mag—Nov. 3700 w.

*8702. Economic Aspects of Immigration. John A. Roebling (The principal propositions dealt with are, in brief, that high wages are necessary for general prosperity in the United States, and that we cannot afford to let unrestricted immigration force wages downward). Am Mag of Civ—Oct. 4000 w.

*8703. The Coming Struggle. Fred E. Tasker (The danger of centralized wealth is regarded as having brought us face to face with the preliminary contests of a great struggle which is to solve the critical problem of labor and capital, the mightiest that civilization has ever encountered). Am Mag of Civ—Oct. 5000 w.

†8803. Co-operative Distribution. Edward W. Bemis (A general account of co-operative societies, co-operative stores, and other co-operative movements and experiments). Bul of Dept of Labor—Sept. 15500 w.

†8804. Recent Reports of State Bureaus of Labor Statistics (Kansas, Montana, New Jersey). Bul of Dept of Labor—Sept. 2000 w.

8827. A Leap in the Dark—Being a Letter on the Silver Question. Thomas C. Clarke (Not a banker nor a "Wall street gold bug," but an old bridge builder and mechanic, having been requested to give his views on the silver question, herein points out the fatal consequences of tampering with the standard of value). R R Gaz—Oct. 16. 3000 w.

†8829. Nicaragua: Trade Routes, Railroad Enterprise, Coffee and Rubber Industries, &c (A mass of valuable commercial information is contained in the special report upon the topics named). Cons Rept—Oct. 13000 w.

†8835. German Law Against Dishonest Business Methods (Law which went into effect July 1, 1896, and whose provisions seem admirably calculated for the suppression of abuses in trade and of unfair competition). Cons Rept—Oct. 1700 w.

†8837. Industries and Working People of Ghent (General description, with statistics). Cons Rept—Oct. 3000 w.

†8838. Vacation Colonies in Switzerland (General description of a system whereby poor school children needing recuperation are afforded vacations in the "Ferien-Colonien," or vacation colonies). Cons Rept—Oct. 900 w.

†8839. German Trade in 1895 (An array of tabulated commercial statistics, with descriptive text). Cons Rept—Oct. 1000 w.

†8840. The United States Manufacturer and the German Market (More effort and the kind of effort needed to increase the trade of the United States with Germany). Cons Rept—Oct. 1400 w.

8867. Our Trade with the South American Republics (Editorial on the past, present and future work of the National Association of Manufacturers). Sci Am—Oct. 24. 900 w.

†8906. An Object-Lesson in Municipal Government. George F. Parker (Showing how public affairs are conducted in the city of Birmingham. A history of successful municipal government in which inefficiency has been converted into efficiency in the municipal conduct of affairs). Century Mag—Nov. 3000 w.

*8917. Japan as an Industrial Power. William Elliot Griffis (The progress and present industrial status of the country). Chau—Nov. 3600 w.

*8922. Tariff Changes and Customs Regulations (Russia, Germany, Belgium, France, Algiers, Portugal, Spain, Austria-Hungary, Roumania, United States, Costa Rica, Chili, China, Japan, Canada, Bahamas, Sierra Leone, Natal and Queensland). Bd of Tr Jour—Oct. 7500 w.

*8928. Popular Superstition on Money and Prices (Combats the belief—ranked as a popular superstition—that as government can fix the volume of money, it can also fix prices of commodities. Tabulated statistics are adduced to show that during a long period of currency expansion, prices of commodities steadily declined, thus opposing facts to the current belief). Gunton's Mag—Nov. 2800 w.

*8929. The Anti-Capital Crusade (The growing hostility to capital is herein characterized as an "economic malignity," and is strongly condemned as fraught with danger to the existing order of things). Gunton's Mag—Nov. 1500 w.

*8930. The Future of English Labor (It is stated as a matter of fact that England has gotten all the good she can out of the free-trade policy and is now leaning towards protection as a remedy for industrial decline. English papers are quoted in proof of the statement). Gunton's Mag—Nov. 2500 w.

*8933. The Saxon Land Credit System (The purposes and membership of this institution, together with remarks upon its loans, funds, debts, elements of safety, &c.). Gunton's Mag—Nov. 1500 w.

†9015. The Plain Truth About Asiatic Labor. John Barrett (While we have something to fear from Japanese competition the author does not foresee the ruinous effects predicted by some, and he endeavors to correct some false impressions that have obtained a degree of currency). N Am Rev—Nov 5000 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

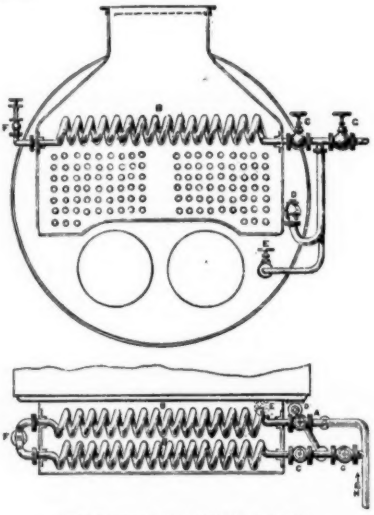
The Harman Feed-Water Heater.

THE simplicity and adaptability of this feed-water heater (herewith represented by a cut reduced from one in *The Engineer*, Oct. 16) will impress engineers at sight. The further points that merit attention are the ease with which it may be applied, not only to new boilers, but also to those already in use; its expansibility to compensate for differences in temperature; the small quantity of fitting and appurtenances needed for it; its evidently durable character; and its apparent efficiency.

It consists of two or more coils of copper pipe arranged in the smoke-box; the feed-water is passed through these coils on its way to the boiler, and the hot gases in the smoke-box surround them, the temperature of the feed-water being thus raised in proportion to the amount of surface given to the coils. It is said that these coils give no trouble and require little attention, and that the movement of the pipe in the coil, while contracting and expanding by heat, prevents scale from forming in the coils. The latter statement does not seem altogether credible, and the liability to scale seems to us the weakest point in the device. However, it would not be difficult to construct a smoke-box in such manner as to permit this heater to be taken out and put in when cleaning is needed, and the removal of scale from the interior of such a coil need not be a difficult matter.

In the engraving A is the inlet valve from pump; B B, heating coils; C, feed valve; D, check valve to boiler; E, circulating valve, with internal pipe to bottom of boiler; F, safety valve; G, intermediate valve; H, feed pipe.

We are also inclined to take with "some grains of salt" the statement that, in the case of the steamship Dione, fitted with this heater, the actual coal-consumption is reduced from 35½ tons to 31 tons, or about 12½ per cent. A reason assigned for this gain in economy over the theoretical is that the apparatus acts as a circulator; and some portion of the saving is probably due to its action in this respect; for, when fires are lighted in a cold boiler, or when fires are put away after being banked for some time, the coils commence to draw the coldest water from the bottom of the boiler through the valve, E, and deliver it again through the boiler check valve, D, at a high temperature.



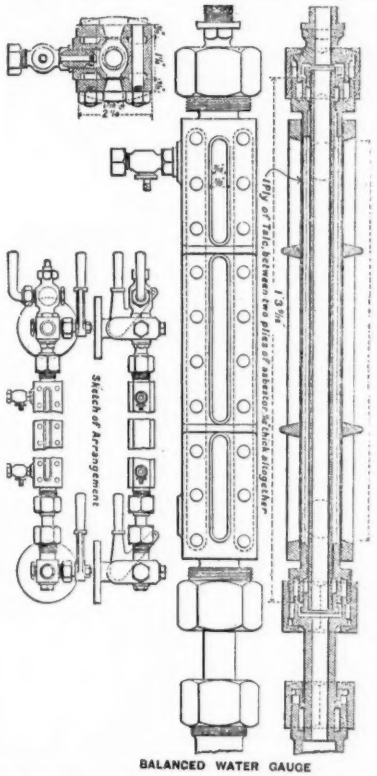
THE HARMAN FEED-WATER HEATER

It is said, in support of this claim and the reason assigned for it, that in half an hour after lighting one fire in one boiler of the above-mentioned steamer, and before the fire had entirely covered the grate bars, the temperature of the water at the outlet of the coils was 200 deg., and the rattling of the check valve showed the circulation to be most active.

A Balanced Water Gage.

ONE of the practical annoyances that have attended the increase in working steam pressure has been the frequent

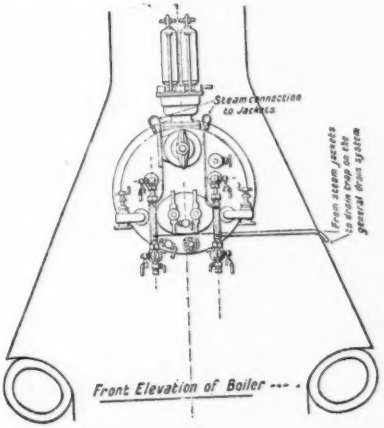
breakage of water-gage glasses. A broken glass renders the gage useless, and yet the indications of the water gage are indispensable to the safe operation of a steam boiler. The breaking of the glass has even led up to serious accident, as was the case in the disastrous explosion on the British warship "*Blake*." The substitution of talc for glass has proved that a transparent material capable of sustaining the required pressure exists; but, as talc soon blackens



BALANCED WATER GAUGE

and becomes partially opaque when in contact with boiler water, it is a very unsatisfactory substitute for glass, requiring a much longer time for renewal when discolored.

In a recent review (Department of Mechanical Engineering for Nov.), in which the limits of steam pressure were discussed, we spoke of the troubles experienced with water gages. We herewith present a condensed description, and reproduce on a smaller scale from *The Engineer* (London) the illustrations, of a new water gage. It is claimed for this gage that it obviates the difficulties attending the use of both glass and talc gages, and that it is entirely unbreakable. These claims challenge the attention of engineers because, if verified, a thing long and much wanted has been supplied. It is asserted that the problem has been solved by the use of both talc and glass in one and the same gage, the glass being exposed to the action of both water and steam, while the talc is acted upon by dry steam only, which does not affect its transparency as does the water. In other words, the glass water tube is steam-



jacketed by a larger talc case. The illustrations show how this conception has been carried out mechanically.

"The gage glass—connecting the steam and water in the usual way—is thus always in equilibrium, being enveloped with steam of the same pressure as that contained within it, and also protected from sudden changes of temperature, and, when once inserted in its fitting, it ought to last a long time. Above we give an outside view and a sectional elevation of the new gage, in which it will be seen that the fittings at either end of the gage glass proper, which connect it to the boiler front, are formed on the principle of a double stuffing-box, the exterior of the glass having an asbes-

tos packing around it similar to that of an ordinary slide rod. This packing at either end is kept in place by a hollow cap or gland, and is thus prevented from detaching itself from the glass, and keeps a perfectly free and open passage right through it for the steam and water.

"The talc case surrounding the glass tube is supplied with dry steam from the boiler through a small cock at its top, while a similar cock at the bottom of the case is connected with an ordinary pipe draining into a small closed vessel, which may be emptied every watch, thus securing a dry atmosphere round the glass. The talc itself, never being in contact with the boiler water, remains transparent, and resists the highest steam pressure, thus making the gage impregnable to the usual trying conditions so detrimental to the ordinary gage glass, as high pressure, blows dealt inadvertently, cold currents of air, or water spray do not affect it. The packing at either end of the glass requires little setting up, and there is no tendency to leakage, although the glass is practically free.

"The fitting is slightly longer than the ordinary gage, to give the same visible range of water; but there is no need to provide for clearance above the cocks for inserting the glass, as the talc case can be removed at the front by simply slacking the coupling nuts, and any part can be tested or examined with the boilers at work. No objection can be raised to the jacketed tube, as, should the glass happen to break, steam and water are merely transferred from inside it to the outer case."

It is said that the English firm which has patented this gage and is beginning to place it on the market has tested it under 160 to 170 pounds' pressure, and will soon place it upon a number of high-class vessels. This being the case, the practical results will speedily show whether the water-gage difficulty has been eliminated, by this so-called "balanced steam gage," from the problem of working high-pressure steam.

We shall wait to see, hoping meanwhile for the success of the invention.

The Policy of the Victorious Party as Concerns American Shipping.

THE victorious party in the recent presidential election stands pledged to a policy of protection for American shipping. Whether or not this pledge shall be fulfilled, there will be an era of warm discussion upon proposed measures looking to its fulfilment. In fact, this discussion has already been active for a year or more in papers devoted to American maritime interests. As a contribution to the data necessary to the formation of an intelligent opinion upon the subject, the table on the opposite page, reprinted from *Seaboard*, and prepared by Mr. William W. Bates, ex-commissioner of navigation for the United States, will be useful. There is no doubt that many people who have postponed the consideration of this question till the election excitement should abate will now give attention to it. The party now coming into power must justify the hopes of the people in the fulfilment of its pledges, or expect overwhelming defeat in the next struggle.

Transatlantic Mail Service Time-Records.

A STATEMENT of time-records of ships carrying mails between New York and Paris, and between New York and London, prepared by Captain Brooks, superintendent of the foreign mail service in the New York general mail service, was printed in the *Iron Age* October 15. As it is an interesting statement in handy form for reference, and short, we quote it.

"American (New York to London *via* Queenstown and *via* Southampton).—'New York,' 15 trips, 172.1 hours; 'St. Louis,' 13 trips, 168.6 hours; 'St. Paul,' 10 trips, 169.7 hours; 'Paris,' 12 trips, 179.2 hours; 'Berlin,' 3 trips, 213.4 hours.

"Cunard (New York to London *via* Queenstown).—'Lucania,' 11 trips, 157.1 hours; 'Campania,' 12 trips, 158.1 hours; 'Etruria,' 12 trips, 169.5 hours; 'Umbria,' 13 trips, 174 hours; 'Servia,' 2 trips, 201 hours; 'Aurania,' 7 trips, 201.9 hours.

"Hamburg American (New York to London *via* Southampton).—'Fuerst Bismarck,' 7 trips, 170.3 hours; 'Normannia,' 7 trips, 174.7 hours; 'Augusta Victoria,'

OUR EXPERIENCE IN NAVIGATION AND THE BALANCING OF FOREIGN COMMERCE.

Statement showing the gain or loss of using our own Shipping or employing foreign in our Commerce. By William W. Bates, Ex-U. S. Commissioner of Navigation.

Years.	American Shipping Owned, Built and Broken off a Year.	Trade. Exports, Value Per Capita Dollars.	Trade. Imports, Value Per Capita Dollars.	Tra'n'p'rtation Value by American vessels. Exports, per cent.	Tra'n'p'rtation Value by American vessels. Imports, per cent.	Resulting Balances. Per Capita. Of Trade. Per Cap. Favorable Dollars.	Resulting Balances. Per Capita. Of Trade. Per Cap. Adverse Dollars.	Resulting Balances. Per Capita. Of Transportation. Exports. Favorable Dollars.	Resulting Balances. Per Capita. Of Transportation. Exports. Adverse Dollars.	Resulting Balances. Per Capita. Of Transportation. Imports. Favorable Dollars.	Resulting Balances. Per Capita. Of Transportation. Imports. Adverse Dollars.	Resulting Balances. Per Capita. Of Commerce as a Whole. Favorable Dollars.	Resulting Balances. Per Capita. Of Commerce as a Whole. Adverse Dollars.	Freights, Per Cent. age of Imp'rt'n	Historical Notes.	Practical Remarks.
1790	09.75	5.14	5.85	40	41	.....	0.71	.....	0.12	.....	0.19	.....	1.02	22 & 18	British and French at War.	In commerce, a ship serves two purposes: First, that of transportation for the merchant; second, that of earning and saving for its *nation* a competence of wealth and power. The merchant's use of shipping is beneficial, but the national service is invaluable—first, in balancing foreign trade; second, in creating means for maritime defence. A shipless nation is always in foreign debt. Its exports and imports may balance, while its commerce, as a whole, is shortcoming, the balance to be paid in coin. The explanation is this: Comuerce consists of *transportation* as well as *trade*. One is a complement of the other. The charge for freight follows the cargo; it is a virtual export or import, as the case may be. By our own ship abroad, it increases our credits there. By our own vessel home, it saves debt here. Thus transportation must needs be balanced, as well as trade; either by trade itself, by transportation, or by exports or imports of precious metals. Where alien merchants, underwriters and bankers, as well as foreign vessels, are employed in a nation's commerce, *as was in ours*, only a very large excess of exports over imports can, or will, prevent an adverse balance of commerce. Insurance and commissions, profits and freights, have countervailed the largest balances of trade. Only the poor or slack among the nations have ever tolerated a passive commerce in foreign hands and ships. Every power in Europe, from Great Britain to little Portugal, is paying out money to maintain at least a *show warrior*. Until the year 1874 our balances of trade, with few exceptions, were adverse. Our commerce began with adverse balances, foreigners, then as now, largely carrying and controlling it; but *protection* to our *navigation* soon gave preponderance to our carriage, and changed balances from adverse to favorable down to the war—1861. In 1812 we first had a favorable balance of trade. Of 59 prior adverse balances, 16 were converted into favorable for *commerce*. In the period while our carriage preponderated—1791 to 1861—for 71 years—we had 59 adverse balances of trade, of which 47 were converted into favorable balances of *commerce*. When our carriage failed to convert, it was owing to a state of war, to tariff changes, or low duties. Where unconverted, adverse balances were minimized. The adverse and the favorable balances in the 71-year period sum up to $419,701,656, and to $807,481,210, respectively, or as *one to two*, greatly to our advantage. For the last 35 years the balances of transportation have all been adverse. Beginning at $4,277,000, in 1862, they enlarged annually and reached $183,782,430, in 1892. For the period they aggregate $2,878,-518,913; and in the last 7 years have averaged $144,159,381. In the 35 years we had 29 favorable balances of trade, but 9 of these were changed to adverse, and our favorable balances of commerce cut down, to 11, as against 24, in spite of *ample exports* and the *high tariff* prevailing. The result for the period is an adverse aggregate balance of commerce of $1,674,572,921, converted from a favorable balance of trade of $1,203,945,992, making a loss of $2,878,518,913, by foreign carriage—a waste of wealth at once needless, exhausting and dangerous.
1791	09.81	4.68	7.19	52	68	.....	2.51	0.04	.....	0.21	.....	.....	2.26	.....	Tariff raised 2½ per cent.	
1792	10.55	4.35	7.80	51	67	.....	2.55	0.24	.....	0.46	.....	.....	1.85	.....	Algerine piracies begun.	
1793	08.96	6.03	7.21	77	82	.....	1.18	0.97	.....	0.87	.....	.....	.....	25 & 20	Shipowning protected, 1789.	
1794	10.32	7.42	7.77	86	91	.....	0.35	1.34	.....	1.28	.....	.....	2.27	.....	Tariff raised and extra duties by foreign ships.	
1795	12.03	10.48	15.26	88	92	.....	4.75	1.99	.....	2.56	.....	.....	.....	0.20		
1796	12.53	20.60	17.29	90	94	.....	3.04	2.85	.....	3.03	.....	.....	2.83	.....	Shipbuilding protected, 1792.	
1797	12.45	11.70	15.54	88	92	.....	3.82	2.25	.....	2.61	.....	.....	1.04	.....	War with France.	
1798	12.06	12.30	13.70	87	91	.....	1.40	2.27	.....	2.25	.....	.....	3.12	.....	British bank all failed.	
1799	12.63	15.27	15.35	87	90	.....	0.08	2.43	.....	2.45	.....	.....	4.80	.....	Our commerce flourishing.	
1800	12.33	13.37	17.19	87	91	.....	3.82	2.48	.....	2.81	.....	.....	1.47	.....	Peace with France.	
1801	11.26	17.06	20.19	87	91	.....	3.13	3.15	.....	3.50	.....	.....	3.52	.....	"Napoleonic" wars continue.	
1802	09.74	12.71	13.39	85	88	.....	0.68	2.22	.....	2.03	.....	.....	3.57	.....	War with Barbary States.	
1803	09.84	9.47	10.28	83	86	.....	1.51	1.56	.....	1.56	.....	.....	1.61	.....	Our Navy begun.	
1804	10.82	12.78	14.09	86	91	.....	1.22	2.30	.....	2.29	.....	.....	3.37	.....	Tariff and Tonnage duties raised.	
1805	11.81	15.23	19.22	89	93	.....	3.99	2.97	.....	3.30	.....	.....	2.38	.....	British impressment begun.	
1806	12.28	15.69	20.09	89	93	.....	4.31	3.06	.....	3.44	.....	.....	2.19	.....	British and French capture our vessels.	
1807	12.54	16.35	20.78	90	94	.....	4.53	3.25	.....	3.65	.....	.....	2.37	.....		
1808	11.09	3.27	8.31	88	93	.....	5.04	0.62	.....	1.43	.....	.....	.....	2.99	Embargo act in force.	
1809	13.77	7.42	8.43	84	88	.....	1.01	1.21	.....	1.28	.....	.....	1.48	.....	Non-intercourse act passed.	
1810	13.43	9.52	11.80	84	85	.....	2.28	1.84	.....	2.03	.....	.....	1.19	.....	Culmination of tonnage per capita.	
1811	10.18	8.30	7.14	86	90	1.06	.....	1.48	.....	1.14	.....	.....	3.68	.....		
1812	09.78	4.99	9.96	80	85	.....	4.97	0.75	.....	1.40	.....	.....	.....	2.82	War with England.	
1813	08.40	3.50	2.76	65	71	0.74	.....	0.27	.....	0.23	.....	.....	1.24	.....	Much tonnage laid up.	
1814	08.17	0.84	1.58	51	74	.....	0.74	0.01	.....	0.05	.....	.....	.....	0.68	Our harbors blockaded.	
1815	10.05	6.33	13.41	71	77	.....	7.18	0.58	.....	1.30	.....	.....	5.30	22 & 18	Peace with England. Free ship act.	
1816	09.12	9.45	16.97	68	73	.....	7.52	0.75	.....	1.40	.....	.....	5.37	.....	Tariff act, moderate duties and flood of British goods.	
1817	08.94	9.84	11.14	74	79	.....	1.30	1.04	.....	1.16	.....	0.90	.....	.....		
1818	10.39	10.18	13.31	80	85	.....	3.13	1.34	.....	1.07	.....	.....	0.12	.....	Tonnage decline, 21 free ship act.	
1819	06.08	7.47	9.27	82	87	.....	1.80	1.05	.....	1.23	.....	0.48	.....	.....	British bank resumption.	
1820	05.95	7.23	7.72	89	90	.....	0.49	1.30	.....	1.11	.....	1.92	.....	.....	American bank resumption.	
1821	05.88	6.53	6.53	84.9	92.7	0.23	.....	0.90	.....	0.97	.....	2.10	.....	.....	Second period of line to Liverpool.	
1822	05.63	7.02	8.09	84.1	92.4	.....	1.07	1.05	.....	1.23	.....	1.21	.....	.....	London and Havre lines started.	
1823	05.63	7.04	7.31	87.4	92.1	.....	0.27	1.16	.....	1.11	.....	2.00	.....	.....	British W. I. ports opened.	
1824	05.79	6.69	7.37	88.7	93.4	.....	1.28	1.19	.....	1.15	.....	1.06	.....	.....	Third free ship act. Tariff raised.	
1825	05.88	8.80	8.37	90.3	95.3	0.54	.....	1.59	.....	1.35	.....	0.61	.....	.....	British W. I. ports closed again.	
1826	06.00	6.69	7.32	89.6	95	.....	0.63	1.17	.....	1.18	.....	1.72	.....	.....	Culmination of our carriage.	
1827	05.87	6.92	6.68	87.5	94.3	0.24	.....	1.14	.....	1.07	.....	2.45	.....	.....	Free-shipping policy in control.	
1828	06.13	6.91	6.72	84.5	91.4	.....	0.60	0.89	.....	0.95	.....	1.08	.....	.....	Final act for unprotection of ships.	
1829	04.70	5.77	5.94	86	93	.....	0.17	0.88	.....	0.81	.....	1.47	.....	20 & 16	Tariff raised, 1828.	
1830	04.17	5.74	5.51	86.3	93.6	0.23	.....	0.83	.....	0.76	.....	1.82	.....	.....	Hard times for shipping.	
1831	04.09	6.13	7.78	80.6	91	.....	1.65	0.73	.....	1.02	.....	0.12	.....	19 & 16	British W. I. opened again.	
1832	04.43	6.38	6.52	79.4	89.6	.....	1.02	0.63	.....	0.93	.....	0.53	.....	.....	Tariff reduced.	
1833	04.63	6.40	10.66	78.5	90.7	.....	4.26	0.62	.....	1.38	.....	.....	2.26	.....	Act for reduction of duties in 1836,'38, '40 and '42, to 20 per cent. horizontal.	
1834	05.18	7.21	7.47	74.4	89	.....	0.26	0.66	.....	0.93	.....	1.85	.....	.....		
1835	05.32	8.18	8.60	77.3	90.3	.....	0.32	0.84	.....	1.09	.....	1.61	.....	.....	Falling prices.	
1836	04.95	8.41	12.41	75.4	90.3	.....	4.00	0.81	.....	1.60	.....	.....	1.59	.....		
1837	04.38	7.47	8.26	77.6	86.5	.....	1.49	0.74	.....	1.04	.....	0.29	.....	18 & 16	*Panic* and Suspension.	
1838	04.39	6.71	7.04	82.8	90.6	.....	0.33	0.79	.....	0.91	.....	1.49	.....	.....	Commerce declined.	
1839	04.35	7.29	9.76	78.4	88.7	.....	2.47	0.70	.....	1.13	.....	.....	0.64	17 & 15	British Mail subsidy to Cunard.	
1840	04.48	7.15	6.28	79.9	86.6	0.87	.....	0.76	.....	0.69	.....	2.34	.....	.....	Low tariff and revenue falling short.	
1841	04.48	6.93	7.28	77.8	88.4	.....	0.35	0.65	.....	0.84	.....	1.14	.....	.....	Wildcat banking.	
1842	04.53	5.78	5.53	76.3	88.5	0.25	.....	0.51	.....	0.64	.....	1.40	.....	.....	Tariff raised. Resumption.	
1843	04.36	5.36	5.47	77	87.1	1.89	.....	0.49	.....	0.28	.....	2.60	.....	9 mos.	First British Chinese war.	
1844	04.66	5.78	5.68	70.5	86.7	0.10	.....	0.40	.....	0.62	.....	1.12	.....	.....	Times improving.	
1845	04.54	5.33	5.78	78.8	87.3	.....	0.42	0.63	.....	0.46	.....	0.67	.....	17 & 15	Annexation of Texas.	
1846	04.60	5.34	5.78	79.2	87.1	.....	0.41	0.47	.....	0.64	.....	0.70	.....	.....	Tariff reduced.	
1847	04.96	7.43	5.77	65.3	77.2	1.66	.....	0.36	.....	0.44	.....	2.46	.....	16 & 14	First American Steamers subsidized	
1848	05.38	6.30	6.80	71.1	82.9	.....	0.47	0.41	.....	0.62	.....	0.56	.....	.....	Gold mining activity booming.	
1849	05.62	6.25	6.28	68.9	81.4	.....	0.03	0.37	.....	0.55	.....	0.89	.....	.....	British free-ship act passed.	
1850	06.33	6.22	7.01	68.1	77.6	.....	1.26	0.31	.....	0.54	.....	.....	0.41	16 & 13	American Clipper ships preferred.	
1851	06.47	7.88	8.79	69.8	75.6	.....	0.91	0 50	.....	0.60	.....	0.13	.....	.....	American steam lines running.	
1852	06.93	6.74	8.37	66.5	74.5	.....	1.63	0.33	.....	0.50	.....	.....	0.80	15 & 12	British subsidies advanced.	
1853	07.59	7.95	10.39	67.1	71.5	.....	2.35	0.43	.....	0.57	.....	.....	1.35	16 & 13	Crimean war to 1856.	
1854	08.18	8.97	11.07	69.3	71.4	.....	2.30	0.56	.....	0.62	.....	.....	1.13	.....	Britain Liverpool iron ships	
1855	08.63	8.04	9.47	73.8	77.3	.....	1.43	0.61	.....	0.67	.....	.....	0.15	.....	British subsidies help steam.	
1856	08.19	10.01	11.06	70.9	78.1	.....	1.04	0.67	.....	0.87	.....	0.50	.....	.....	Second British war with China.	
1857	07 83	10.14	12.86	69.3	71.8	.....	1.88	0.39	.....	0.58	.....	.....	1.02	14 & 11	Tariff reduction and *Panic*.	
1858	07.72	9.09	8.79	75	72	0.30	.....	0.51	.....	0.30	.....	1.20	.....	13 & 10	American subsidies withdrawn, and our steam lines ruined	
1859	07.58	9.55	10.81	69.9	63.7	.....	1.26	0.48	.....	0.29	.....	.....	0.49	.....		
1860	07.58	10.60	11.24	69.7	63	.....	0.64	0.54	.....	0.29	.....	0.19	.....	.....	France and Austria at war.	
1861	07.76	6.78	7.98	73.4	75	.....	1.20	0.35	.....	0.18	.....	.....	1.07	.....	Civil war—High tariff acts.	
1862	06.02	5.79	5.75	54.5	44.8	.04	.....	1.36	0.48	.....	0.29	.....	.....	0.09	Bank suspension—Many ships sold abroad.	
1863	05.75	6.07	7.25	49	43.3	.....	1.18	.....	0.16	.....	0.10	.....	1.44	.....		
1864	04.35	4.64	9.25	30	24.6	.....	4.61	.....	0.24	.....	0.47	.....	5.32	.....	Confederate Cruisers sinking ships.	
1865	04.61	4.76	6.65	35.1	29.5	.....	2.09	.....	0.29	.....	0.28	.....	2.66	.....	Civil war ended.	
1866	03.91	9.82	12.24	37.7	25.1	.....	2.42	.....	0.31	.....	0.61	.....	3.34	.....	Prussia and Austria, France and Mexico at	
1867	04.18	8.13	10.93	39.1	28	.....	2.80	.....	0.21	.....	0.43	.....	3.44	12 & 9	war. Culmination of effort to restore our ships.	
1868	04.06	7.69	9.62	39	33	.....	2.93	.....	0.25	.....	0.30	.....	3.55	.....		
1869	03.97	7.58	11.06	34.9	31.3	.....	3.48	.....	0.27	.....	0.37	.....	4.12	.....	Desperate work of rivals.	
1870	03.76	10.18	11.28	37.7	33.1	.....	1.10	.....	0.32	.....	0.38	.....	1.80	13 & 10		
1871	03.45	11.12	13.15	39.6	31	.....	2.03	.....	0.50	.....	0.50	.....	3.03	.....	British Lloyds degrade our ships, to increase	
1872	03.37	10.04	12.41	39.8	35.5	.....	4.49	.....	0.62	.....	0.71	.....	5 32	14 & 10	British carrying.	
1873	02.33	12.51	15.40	25.7	27	.....	2.89	.....	0.85	.....	0.71	.....	4.45	.....	France and Germany at war.	
1874	03.27	13.70	13.25	24.6	30.2	0.45	.....	.....	0.97	.....	0 53	.....	1.05	.....	Bank contraction and *Panic*.	
1875	03.48	11.68	12.19	23.7	29.8	.....	0.44	.....	0.86	.....	0.50	.....	1.80	.....	American Steam to China and Japan.	
1876	03.36	11.97	10.21	23.4	30.8	1.76	.....	.....	0.77	.....	0.33	0.64	.....	13 & 9	Development, Pacific Ocean trade.	
1877	03.41	12.99	9.73	23.7	31.5	3.26	.....	.....	0.89	.....	0.32	2.05	.....	.....	Treaty with Sandwich Islands.	
1878	03.36	14.60	9.18	23.6	32.3	5.42	.....	.....	1.04	.....	0.29	4.09	.....	.....	Steam to W. I and Mexico.	
1879	03.00	14.54	9.12	21.7	31.6	5.42	.....	.....	1.24	.....	0.20	3.98	.....	.....	Contraction for *resumption*.	
1880	02.62	16.66	13.31	15.7	22	3.35	.....	.....	1.69	.....	0.74	0 92	.....	14 & 10	Foreign steamers increased.	
1881	02.52	17.58	12.52	13.3	19 9	5 06	.....	.....	1.95	.....	0.75	2.36	.....	15 & 10	Resumption accomplished.	
1882	02.39	14.29	13.80	12.8	19.2	0.49	.....	.....	1.49	.....	0.85	.....	1.85	14 & 10	California grain trade increasing.	
1883	02.31	15.34	13.50	13.4	20.7	1.84	.....	.....	1.57	.....	0.65	0.79	.....	.....	French bounty to shipping.	
1884	02.31	13.48	12.16	14.4	23.4	1.32	.....	.....	1.34	.....	0.67	0.60	.....	.....	Tariff carried.	
1885	02.23	13.21	10.28	13.7	21.3	2.93	.....	.....	1.34	.....	0.59	1.00	.....	.....	Germany and Italy, subsidy and bounty ship	
1886	01.71	11.84	10.07	13.2	20	0.77	.....	.....	1.12	.....	0.60	.....	0.95	13 & 9	protection.	
1887	01.67	12.20	11.79	12.2	18.6	0.41	.....	.....	1.18	.....	0.67	.....	1.43	.....	British bounty subvention to steamers	
1888	01.52	11.60	12.07	11.79	18.5	.....	0.47	.....	1.15	.....	0.70	.....	2 32	.....	Foreign steam now well protected.	
1889	01.56	12.11	12.15	11.62	17.08	.....	0.04	.....	1.20-	.....	0.72	.....	1.96	.....	Congress neglecting ours.	
1890	01.47	13.62	13.06	9.04	16.68	1.09	.....	.....	0.97	.....	0.84	.....	1.22	14 & 10	Tariff regulated and lowered.	
1891	01.54	13.82	13.20	9.26	15.85	0.62	.....	.....	1.58	.....	0.96	.....	1.86	.....	Large export of *Gold* to balance foreign trade.	
1892	01.49	15.75	12.65	8.11	17.66	3.10	.....	.....	1.98	.....	0.83	0.29	.....	15 & 10		
1893	01.32	12.76	12.96	6.79	15.45	.....	0.26	.....	1.36	.....	0.80	.....	2.42	13 & 9	Export of *gold* and *Panic*.	
1894	01.31	13.07	9.60	8.74	19.43	3.47	.....	.....	1.39	.....	0.47	1.71	.....	12 & 8	Tariff reduction. Heavy exports of gold.	
1895	01.18	11.60	10.51	8 22	15 48	1.09	.....	.....	1.16	.....	0.58	.....	0.65	.....	Revenue deficient; deep business depression from adverse balances of trade, gold exports and the want of shipping of our own.	
1896	01.15	12.40	10.96	8.56	15.76	1.44	.....	.....	1.23	.....	0.60	.....	0.39	.....		
1897	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....		
1898	.....	.....	.....	.....	.....	.....	Copyrighted	.....	.....	.....	.....	.....	.....	.....		
1899	.....	.....	.....	.....	.....	.....	Sept. 7, 1896.	.....	.....	.....	.....	.....	.....	.....		
1900	Computed and closely approximated from the best information obtainable.															

7 trips, 178.1 hours; 'Columbia,' 6 trips, 177.1 hours.

"White Star (New York to London *via* Queenstown).—'Teutonic,' 13 trips, 170.2 hours; 'Majestic,' 12 trips, 173.6 hours; 'Germanic,' 11 trips, 197 hours; 'Britannic,' 13 trips, 210.4 hours; 'Adriatic,' 2 trips, 232.3 hours.

"North German Lloyd (New York to London *via* Southampton).—'Havel,' 12 trips, 184.6 hours; 'Lahn,' 10 trips, 183.1 hours; 'Aller,' 9 trips, 190.5 hours; 'Spree,' 12 trips, 186.1 hours; 'Trave,' 8 trips, 191.5 hours; 'Saale,' 9 trips, 196.3 hours; 'Ems,' 5 trips, 199.7 hours; 'Fulda,' 4 trips, 201.2 hours; 'Kaiser Wilhelm II,' 1 trip, 219 hours; 'Werra,' 1 trip, 226.7 hours.

"Générale Transatlantique (New York to Paris *via* Havre).—'La Touraine,' 10 trips, 186.3 hours; 'La Bretagne,' 6 trips, 194.1 hours; 'La Bourgogne,' 12 trips, 199.5 hours; 'La Champagne,' 7 trips, 196.9 hours; 'La Gascogne,' 10 trips, 200 hours; 'La Normandie,' 7 trips, 201.6 hours."

Copper Sheathing of Cruisers.

THE advantages of copper sheathing for iron hulls are now recognized. The value of copper on wooden hulls is not alone in protection from the teredo, but also in a large reduction in expense for docking and cleaning. The latter advantage pertains to the use of copper sheathing on iron hulls. *Practical Engineering* (Oct. 9) quotes the *Naval and Military Record* as stating that the results of experience with cruisers prove the usefulness of sheathing their under-water structure.

"The latest convert to this process is the United States, whose naval authorities have been collecting information as to the advantages of sheathing their cruisers with wood and then covering them with copper, to obviate the necessity of frequent docking for cleaning the hull. With an ordinary steel hull it is found that, after five or six months afloat, one-fifth more power is required to maintain ordinary cruising speed than when the bottom was clean. In considering copper and wood sheathing, the fact must not be overlooked that the former process is the more costly.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*8662. Absence of a Standard in Battle-Ship Design. Ridgely Hunt (A comparison of the navies of the world with regard to size, gunpowder, armor, speed and coal capacity). Eng Mag—Nov. 3700 w.

*8668. Torpedo-Boat Destroyer "Entre Rios" (Illustrated description). Engng—Oct. 2. 700 w.

*8673. H. M. S. First-Class Cruiser "Powerful" (Illustrated description). Eng, Lond—Oct. 2. 1300 w.

8707. The New Steamship "La Grande Duchesse" (Illustrated description). Eng—Oct. 10. 1000 w.

8708. Our Experience in Navigation and the Balancing of Foreign Commerce. William W. Bates (Tabulated statement showing the gain or loss to the United States by using American shipping or employing foreign vessels in its commerce). Sea—Oct. 8. 800 w.

*8752. New Steam Launch for the Ambulance Service of the Metropolitan Asylums Board (Illustrated description of an ambulance boat designed and built for river ambulance service). Ind and Ir—Oct. 9. 1500 w.

8777. A Warship Run by Air (Reprinted from "N. Y. Evening Post." Description of compressed air machinery for steering, turning turrets, working guns, &c., of the U. S. monitor "Terror"). Com Air—Oct. 1300 w.

*8943. Torpedo-Boat Destroyer "Capitan Orella" (Illustrated description and comments). Engng—Oct. 16. 1200 w.

*8954. H. M. S. "Powerful" (Description of second set of trials with editorial comment). Eng, Lond—Oct. 16. 2300 w.

*8994. Engines of Torpedo-Boat Destroyers "Salmon" and "Snapper" (Illustrated description). Engng—Oct. 23. 900 w.

*9017. The North of England Shipbuilding Industry. Henry F. Swan (Extracts from a presidential address delivered before the Northeast Coast Inst. of Engs. Review of the past and present of the industry. The tendency to increase the size of vessels and the increase of steam pressures are particularly noticed). Col Guard—Oct. 23. 3500 w.

9076. The Electric Yacht "Utopian" (Illustrated description). Elec Wld—Nov. 7. 1200 w.

*9116. The Engines of H. M. S. "Diana" (Illustrated description). Engng—Oct. 30. 1000 w.

We supply copies of these articles. See introductory

MECHANICAL ENGINEERING

Liquid Fuel for Steamships.

THE advantages that would attend the successful use of liquid fuel for marine propulsion are so great and obvious that, notwithstanding the repeated failures which have attended experiments in this direction, inventors are still grappling with the problem. We believe complete success will ultimately reward this persistence, and deem it highly probable that the present generation will see the use of liquid fuel fairly inaugurated.

As all liquid fuel has either to be atomized, or gasified, in order to burn it, these method appears to be the only approaches to a practical solution of the problem. For the larger installations atomizing has had the preference hitherto.

Nearly all the great naval powers have been experimenting with liquid fuel for marine propulsion. Progress with stationary oil engines on land has been rapid but it is not generally known how far the use of oil fuel has progressed for railway and marine purposes. This article will present an outline of progress in these directions.

Russia is using liquid residues from the distillation of petroleum on more than seventy-two locomotives. England recently adopted liquid fuel for one of its torpedo boats, now completed, which is provided with oil storage tanks in place of coal bunkers. Most of the Russian cruisers are fitted for burning liquid fuel. Last, but not least, the United States government, if current reports may be credited, has found in an invention of Mr. J. S. Zerbe a successful method of using oil as fuel for marine purposes; so that, perhaps, we ought to admit that the use of oil as fuel is already fairly inaugurated.

But there still remains the question of the supply. For general use oil must be at least as cheap per h.-p. hour as coal. For marine purposes, such as passenger steamers and war-ships, its advantages will more than balance a considerable difference in cost; but who can now say precisely what that difference will get to be in the course of a quarter of a century? It is true that new supplies are from time to time discovered; but the consumption for all purposes increases annually, and, unless the earth is a huge manufactory of petroleum, the time must come when all supplies will be exhausted. The extent of petroleum deposits cannot be estimated as well as that of known coal deposits, and, while there are large stores of mineral oil in the earth's crust, it is easy to conceive of a growth in demand that would double present prices. Nevertheless, the use of oil as fuel would still obtain for all purposes wherein its advantages counterbalance its increased cost; and, as we do not now perceive such advantages in its use for stationary and locomotive engines, we are inclined to the belief that its employment for these purposes will not be maintained for a very long term of years, except, perhaps, in some special service. This, of course, implies our belief that the oil-supply is not likely to meet a general demand for oil fuel at a sufficiently cheap rate.

In connection with this aspect of the subject, an editorial review of the world's oil-supply in *Engineering* (London, Oct. 30) is of interest. It says:

"The United States and Russia are our great sources of supply; the former last year produced 53,000,000 barrels of 42 gallons, and the latter 38,333,000 barrels, and carefully-compiled statistics fail to account for more than 95,000,000 barrels as the world's production; but there is no doubt that much oil found is used locally, and therefore not accounted for. Austria-Hungary gives 1,250,000 barrels; Canada, 802,574 barrels; India, 295,994; Java, 293,654; while Peru, Roumania, Germany, Japan, and Italy are amongst the other producing countries. Great Britain's quota, if we exclude the two million tons of shale oil, is inappreciable.

"That the supply is scarcely equal to the demand is in some measure indicated by the continued high level of rates. The output in the States, especially in Ohio, Indiana, and California, shows a great increase. Only once, in 1891, has the total been greater than that for 1895, already given, and withal stocks have greatly decreased. In the great Appalachian oil-field, producing 31,000,000 out of the 53,000,000, the stocks only include 5,333,000 barrels. Thus prices have increased. Indeed, the average is higher than in any year since 1877, and the lowest rate last year was above the highest reached in 1894. The average price was 5s. 7½d. per barrel of 42 gallons in the Appalachian district, while over all the price was 4s. 2½d., against 3s. in the previous year. Of course the price of oil is often artificial, due to market manipulation, especially in the States, but there has been no appreciable difference in prices in countries where such influences are not at work.

"We have given the production in the States; and, as to the prospects of increased supply, some interesting points are brought out in a recent report made to the geological department by Mr. Joseph D. Weeks. Between twenty and twenty-five promising wells have been sunk in the Appalachian field, two yielding about 6,000 gallons per day. In the Los Angeles district of South California there has been great extension, the total having trebled in three years. In Wyoming also there is increased activity, but the difficulty is the absence of means of cheap transport. The oil has to be hauled fifty miles in road wagons; but Mr. Weeks predicts that, with facilities to operate, 'it would be only a short time until the excitement of early days in Pennsylvania would be duplicated.'

"It is, however, from Peru that the greatest augmentation of supply may be anticipated. The principal field is in the department of Piura, and estimates have been made as to the area yielding petroleum, one of them putting it as high as 7,200 square miles. Since the Pennsylvanian field is only 350 square miles, and in thirty years has given forth 516,000,000 barrels, the prospects for Piura seem bright. Energy, it is said, is alone required. The crude petroleum contains 84.9 per cent. of carbon, 13.7 per cent. of hydrogen, and 1.4 per cent. of oxygen. The oil wells generally need to be 800 feet deep, although it has been struck at 30 feet, and the maximum seems 1,200 feet. The cost of a well 1,000 feet deep is put at about £500; 20 large wells would supply a refinery, and the cost of such an establishment would be £20,000. Of 49 wells bored since 1892, 44 have been productive, and some of them yield 30,000 gallons per day. A London company has been working some of the wells, and the imports of oil have decreased to one-third the volume of 1889, the price of the local oil being one-third that of North American petroleum. Crude oil, too, is being used on the locomotives on all the Peruvian railways, in several manufacturing establishments, and in the gas works.

"In Russia 269 new wells were drilled last year, 133 being deep wells, the average depth of all being 540 feet. This is a higher mean than usual, and in six years 1,371 wells have been drilled. The average number in operation now is 622, producing, as we have already stated, 38,000,000 barrels, of which 26,000,000 are pumped, the remainder flowing freely. The pumps consist of buckets worked by windlasses, and bring at each stroke a barrel of crude oil. The total output has been steadily increasing. In 1889 there were 278 wells, yielding 20,000,000 barrels; now 622 wells yield 38,333,000, so that there has been a slight decrease in the average yield per well."

Charging Cupolas.

SOME practical hints upon this subject contributed by Mr. E. Grindrod to *The Foundry* for September are worth considering, though doubtless they will not be new to skilful foundrymen. The management of the cupola is one of the nice points in foundry economy, often determining the success or failure of a day's melt, even if not in the end determining the success or failure of the foundry itself. Too often the charging of the cupola is done in so heedless a way that castings

are ruined that otherwise would have turned out well. We can remember an instance where three successive engine cylinders were spoiled in the foundry by mixing into the charge fragments of scrap containing brass bolts, the zinc in which alloyed with the iron in spots that would take the edge off the best tools used in fitting. This was an instance of gross carelessness in the management of a large establishment. If such things are possible in a large establishment, they are perhaps more liable to occur in smaller ones, though this does not logically follow.

Mr Grindrod evidently does not rely upon the blast-meter as a sure guide to all that goes on in a cupola, and believes in the capacity of the latter to tell its own story, provided the foundry foreman is competent to understand it, when told. He believes "the cupola should be consulted before the meter."

"The cupola will melt the same one day as another, providing the conditions are the same, and the secret of successful cupola management is to make the conditions as nearly alike as can possibly be done by mixing heavy and light irons so that they will be nearly the same for one day as another,—not by picking out all the small iron first, and leaving the heavy pieces to accumulate until all the small scrap is gone, and then being compelled to use the heavy scrap all at once, so that any one not thoroughly up in the cupola business may have trouble in melting iron. In charging a cupola it is very necessary that the proper amount of kindling wood and heavy wood be used to get the coke burning briskly, and the cupola tender should not put on too much coke at the start, but keep adding the bed coke as the cupola burns through, keeping enough coke back to level up the bed before charging. Another important factor in cupola practice is that the bed coke and the first two charges ought to be picked coke; that is, no small coke should be charged until the third charge. This keeps the tuyeres clean by keeping the melting point at a sufficient height above the tuyeres so that no pieces of iron can get down to them before being thoroughly melted."

With reference to reliance upon blast-meters, the author narrates an episode that throws some light upon what may take place in a cupola, even when provided with a good blower. The cupola of the shop in which the episode occurred had a No. 8 Sturtevant blower.

"We had tried to take off a heat every day for six days, and did not succeed in getting poured from one ton to thirty hundredweight at any one of the six heats. The foreman said they could not get enough wind. Just fancy! On the sixth day the superintendent asked me (I was a stranger at the time) what I supposed was the matter. I told him that he did not have fuel enough on his bed, and that he was blowing on iron instead of coke. He simply laughed at me and walked away, and at this time they would throw off the governor belt and let the engine blaze away as fast as it could run. Now, if we had owned a blast-meter at this time, it certainly would have shown a great pressure, but the wind was doing no good."

Mr. Grindrod thinks "it is a very good plan to make the first charge of iron light iron, if it can be done, as this puts no heavy strain on the bed, but keeps it in good condition for the heavier charges." He does not regard it as "good practice to melt any more iron on the bed than on the other charges," and makes it a point to melt light iron on the last charge, as it makes clean and quick melting. "Now, in regard to the iron to be charged, the scrap should be assorted, the heavy chunks placed in the middle of the cupola, and should never be put on before the third charge, and never on the last. It should lie with the foreman to say how many chunks he can carry successfully in a charge, and, by way of experiment, he must be sure he does not put on too many at first, but feel his way by starting with a little, and, if his cupola melts even, to increase them until he can tell just about what his cupola will melt successfully. Another important point is in having charges level. There should be in every charge enough small iron to fill up all holes, for close charging is economy in time and fuel; open charging is wasteful in fuel, and

the melting is not even. If the above points are followed, I am satisfied no person need have any trouble about melting iron even, hot, quickly, and economically."

Differential Recorder for Gaging Flow of Water from Submerged Orifices.

ONE of the concomitants of water-power supply from large dams owned by companies, and from which many manufactories obtain their supply of power at rates proportioned to their consumption, is the measurement of flow, respectively, to the different consumers. Neither hydraulic engineers or owners of factories need to be reminded of the dissatisfactions liable to be experienced by both parties to such a transaction. The origin of some of these dissatisfactions lies in the nature of weir measurement, as pointed out in an article in *The Engineer* (London, Oct. 2). The article deals with a new instrument for measuring water-flow, invented by Dr. J. H. T. Tudsbery for a different purpose, but adapted to water gaging by Sir W. H. Bailey.

We herewith reproduce the illustrations and condense the description, not only on account of the ingenuity of the device, which renders it an interesting mechanical study, but also because its action and the principles involved are likely to interest all practising engineers. Without touching upon the liability to error in weir measurement, which the article reviewed points out, or the advantages of, and hitherto existing objections to, submerged orifices as compared with weirs for measuring flow of water, we simply remark that it is in connection with such orifices that Dr. Tudsbery's differential recorder is used. It is claimed that it removes the only serious practical objection to the otherwise desirable method of gaging by submerged orifices,—to wit, the hitherto existing necessity of making two observations to determine the head.

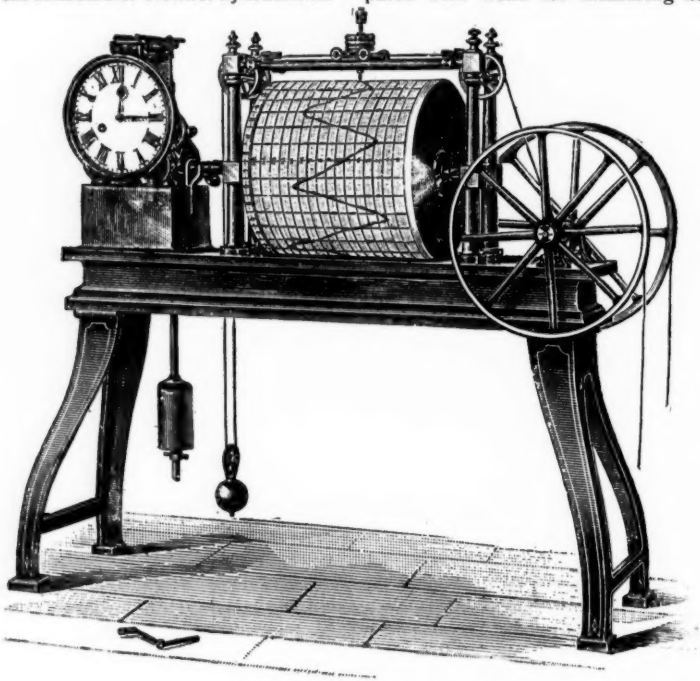


Fig. 1—TUDSBERY'S RECORDER

"Its essential feature is the combination,

by means of a suspended pulley, of the actual motions of two floats to reproduce their relative motion on any desired scale in a single pen or pencil of the kind with which recording gage apparatus is ordinarily equipped. It will be understood that by the use of two pencils, one fixed to each float, the head would be measurable by the difference in the space separating the two traces, but Dr. Tudsbery, by using one pencil on the right of a line coupling the two floats, gets a differential motion, and the head is measured by the space between the base line on the drum and the pencil trace. . . . This contrivance enables the head, or relative water levels, to be measured directly in a single operation, no matter how the absolute water-levels on either side of the orifice may vary.

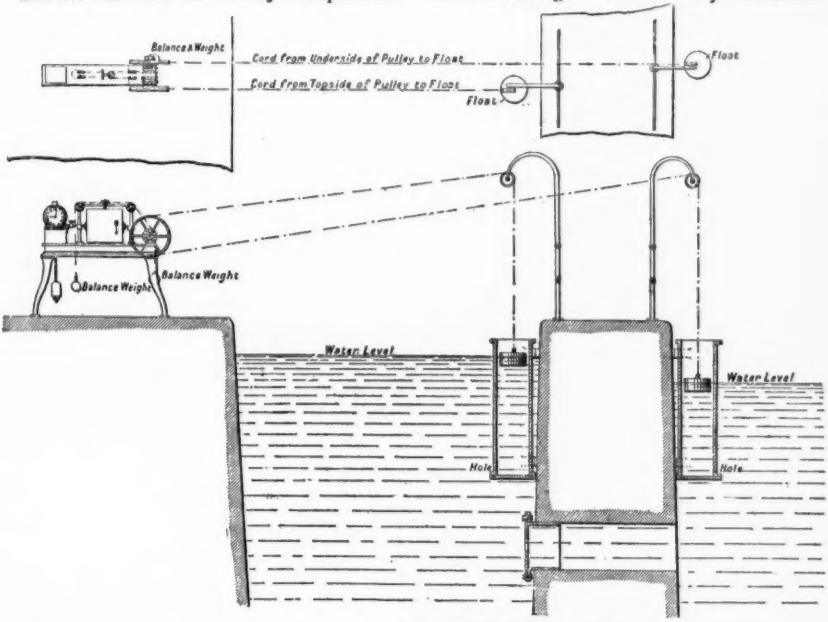


Fig. 2—DIAGRAM OF RECORDER

"The determination of the coefficients of discharge proper to such vertical submerged orifices as are referred to has been within the last few years made the subject of careful inquiry by several investigators, among whom may be specially mentioned Mr. T. G. Ellis and Mr. Hamilton Smith. Reference to the work on 'Hydraulics' by the latter engineer will convince any person of the importance attaching to the question of gaging by means of orifices, and of the care that has been exercised to obtain trustworthy coefficients of discharge applicable to them. For the coefficients applicable to larger submerged orifices, such as are met with in river, canal, and dock works, the investigations of Mr. R. H. Rhind, published in the 'Minutes of Proceedings of the Institution of Civil Engineers,' vol. lxxxv., may be consulted with advantage whilst many valuable isolated data are found in the pages of occasional papers and essays treating of particular hydraulic works.

"The recorder may be described as consisting of a cast-iron lathe bed on legs. It is fitted with an eight-day pendulum clock beating seconds; the drum is 42 inches in circumference, revolving once in seven days, giving ¼ inch to the hour on the diagram, the drum being 14 inches long, recording a difference in level of 2 inches to the foot for a fluctuation of 6 feet. These measurements may be varied according to the delicacy of the diagram required."

It is said that one of these recorders has recently been placed at the mouth of the river Weaver to indicate and record the amount of water flowing through the Manchester ship canal, that they have been adopted by the Western Australian government for tide gages, and that the British fisheries commission is about to use them for investigating and indicating the fluctuation of rivers.

Interchangeable Machine Details.

In a discussion of the accuracy of work produced in the shops of H. Bollinckx, a famous Belgian steam-engine builder, the use made of emery grinding machines in securing accurate fitting of hardened surfaces is particularly mentioned by *The Engineer* (London). While it thus appears that the value of emery grinding as a shop method is recognized in Europe, it also appears from the same article that English shops are and have been slow in adopting it.

"H. Bollinckx . . . gets up his work in a way not as yet nearly as extensively adopted as it deserves to be in this country, mainly by the use of emery grinders. All the steel work, having been brought nearly to shape and size, is then hardened, and subsequently gone over with emery wheels fitted in special tools designed for the purpose. When the steel is carefully finished first, if it is subsequently hardened a certain amount of distortion is sure to take place, which is fatal to accuracy, and the result is that steel unhardened is only too often used. The emery grinder gets over this difficulty, and surfaces of extreme hardness can be adopted, and thus their durability is much augmented. The precision obtained is so great that the cranks are fixed on the shafts and levers on weigh-shafts without any keys, the parts being forced into their places. More noteworthy still, the fly-wheels are forced on their shafts, and have no keys.

"We believe that H. Bollinckx is the only engineer who has had the hardihood to pursue this system so thoroughly, and in all cases his practice has been successful.

"The Corliss valve rods and covers are got up so true that they are steam-tight, metal to metal, not the smallest atom of packing being used. The surfaces are simply greased and bolted together. All the workmanship is throughout of the finest possible kind, all dimensions being worked to with a minute accuracy so unusual in England that we can only name two firms which have adopted a system which has everything to commend it. The great obstacle, we have been told, to its adoption in this country is that it is very difficult to find Englishmen who will work to so high a standard of excellence,—a statement the general truth of which we venture to doubt."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

THE MACHINE SHOP.

8720. Blacksmithing Operations. B. F. Spalding (Working cold metal, drop forging, undercut dies, a mortised die, fatigue of metals, rate of stress and of recovery, proper heats, heavy drops). Am Mach—Oct. 15, 2500 w.

8721. Some Practical Examples of the Use of Compressed Air in Machine Shops, a Belt Shifter, Centre Grinder, Bolt Cutter (Illustrated descriptions of applications named in the title). Am Mach—Oct. 15. 800 w.

8795. The Lorain Foundry Company (Illustrated description of a completely up-to-date foundry, recently built and equipped, and considered to be a model establishment). Ir Age—Oct. 22. 1000 w.

8800. Molding Large Pulleys. L. C. Jewett (Illustrated description of a departure from ordinary methods). Am Mach—Oct. 22. 900 w.

*8855. Copy Work (A dissertation on standard guides for controlling cutters). Eng, Lond—Oct. 9. 2000 w.

*8887. Interchangeable Details of Machinery (The necessary appliances for the production of interchangeable details are herein ably discussed. Editorial). Mach, Lond—Oct. 15. 2200 w.

8924. Design of Stepped Cones (Klein's Diagram, which is convenient and sufficiently accurate, is illustrated and the method of using it explained). Am Mach—Oct. 29. 1800 w.

8991. System in the Drafting Room.

We supply copies of these articles. See introductory.

James C. Hemphill (Illustrated Description of a system in actual use for arranging, classifying and indexing miscellaneous drawings for easy reference). Mach—Nov. 700 w.

9046. Band Saws for Metal Work (Translated and condensed from "Zeitschrift des Vereines Deutscher Ingenieure," by Gus C. Henning. Illustrates and describes forms of band saws used in some of the most famous shops, and presents the features of current practice with these tools). Am Mach—Nov. 5. 3,800 w.

9047. The Bottom of a Foundry Cupola. L. C. Jewett (A leaf from the experience of a practical foundryman). Am Mach—Nov. 5. 1300 w.

9048. Inserted-Tooth Mills. Horace L. Arnold (Present practice in the use of these mills in some notable manufacturing establishments). Am Mach—Nov. 5. 1100 w.

9049. Circular Milling. C. O. Griffin (Illustrated description of a successful attachment to go on the horizontal spindle machine and to do face-plate work). Am Mach—Nov. 5. 1100 w.

9050. Handle-Bar Bending. Hugh Dolnar (Illustrated description of current methods). Am Mach—Nov. 5. 1000 w.

9052. Annealing. H. K. Landis (General remarks upon the importance of annealing in many operations. Its nature and effects). Ir Age—Nov. 5. 2000 w.

9109. Improvements in Cupola Practice (Answers of prominent foundrymen to a circular letter of inquiry as to the direction in which there is greatest room for improvement in foundry practice). Ir Tr Rev—Nov. 5. 1200 w.

STEAM ENGINEERING.

8713. The Ball Engines at the Apollo Iron and Steel Works (Illustrated detailed description of engines installed at the great rolling-mill of the Apollo Iron and Steel Co., at Vandergrift, Pa.). Ir Age—Oct. 15. 600 w.

*8751. The Compound Winding Engine at the Great Western Colliery Company's Pit, with Notes on Its Comparative Steam Economy. Hugh Bramwell (Illustrated description of the engines, with numerous indicator diagrams and tabulated data). Ind and Ir—Oct. 9. 1800 w.

8762. Problems in the Use of Liquid Fuel (General review of the present state of the art and of recent Government experiments with oil fuel and appliances for using it). Safety V—Oct. 1700 w.

*8782. A Recording Indicator. W. O. Amsler (Design of this instrument). Sib Jour of Eng—Oct. 2000 w.

8788. Testing Steam Plants (Editorial argument favoring the testing of steam in working condition when operated in the manner which the designer planned, and determining how much coal is required to do the work). Eng Rec—Oct. 17. 1300 w.

*8856. Combustion of Bituminous Coal in Boilers. (Difficulties in obtaining smokeless combustion referred to varying composition of coal which renders necessary a variable supply of air for combustion). Eng, Lond—Oct. 9. 600 w.

8923. A Triple-Expansion High-Speed Engine (Illustrated detailed description). Am Mach—Oct. 29. 1000 w.

8925. American Locomotive Pistons (From the report of a committee of the Amer. Ry. Mas. Mech.'s Assn. Illustrated description of various forms used in American locomotive practice). Am Mach—Oct. 29. 1800 w.

8947. Inverted Triple-Expansion Vertical Corliss Engine at the De Beers Mines, South Africa (Illustrated detailed description). Power—Nov. 1100 w.

8949. The Barnard Water-Cooling Apparatus (Illustrated detailed description). Power—Nov. 1000 w.

*8988. The Economic Combustion of Fuel. Frederick Grover (The volumes of air needed for economical combustion are indicated graphically, and losses of heat are indicated in the same way). Prac Eng—Oct. 23. 1800 w.

8992. Valve Gears. E. T. Adams (The author promises with much that is old to present something new in the treatment of the subject. The first part deals with the theoretical indicator card, and construction of the slide valve). Mach—Nov. Serial, 1st part. 2700 w.

*9005. Watson's Balanced Water Gauge (Illustrated description of an unbreakable water gauge for steam boilers). Eng, Lond—Oct. 23. 800 w.

*9064. Reading the Indicator Diagram. F. F. Hemenway (Explanation of the significance of peculiarities of indicator diagrams adapted to the comprehension of those who have not familiarized themselves with the use of the instrument). Loc Eng—Nov. 2000 w.

9071. Notes on Coal. Charles F. White (Read before the Western Soc. of Engs. Data and observations on the water measurement in coal tests, variations in repeated tests, and notes on the relations of high-grade and low-grade coals. With discussion). Sta Eng—Nov. 3500 w.

MISCELLANY.

*8661. The Relations of Invention and Design to Mechanical Progress. C. L. Redfield (A comparative analysis of discovery, invention, design and manual skill and of the methods of fostering them). Eng Mag—Nov. 2800 w.

8671. The Theory of Energy in Hydraulics. L. M. Hoskins (The author attempts to supplement what he thinks to

be an inadequate treatment of this subject). Am Gas Lgt Jour—Oct. 12. 1200 w.

†8701. Boiler Bearings (Illustrated description of a roller bearing as applied to car axles). Ind & East Eng—Sept. 12. Serial. 1st part. 2800 w.

8715. The Bicycle Wheel. E. D. Sewell (The suspension wheel in the various forms it has assumed since first invented by Leonardo da Vinci in 1490. Illustrated description). Sci Am—Oct. 17. 1800 w.

8722. Reversing Motors, with Magnetic Brake. Willim Baxter, jr. (Illustrated description of an application of the magnetic brake to a series-wound motor, and also the manner in which it is connected with the circuit wires). Am Mach—Oct. 15. 1000 w.

*8769. Address of Sir Douglas Fox to the Mechanical Science Section of the British Association (General review of progress). Engng—Oct. 9. 7000 w.

8770. A Modern Motor (The advantages of gas engines in points of economy, efficiency, cleanliness and safety). Pro Age—Oct. 15. 1700 w.

8771. Gas Engines in the Casino of Royan (Illustrated description). Pro Age Oct. 15. 1400 w.

8772. Gas Engines for Isolated Electric Plants (Illustrated description of experiments with a 10 h. p. gas engine for isolated lighting at Racine, Wis.). Pro Age—Oct. 15. 700 w.

8773. Gas vs. Steam Engines for Hoisting (General review with numerous examples. Illustrated). Pro Age—Oct. 15. 1800 w.

8774. Gas Engines in the Belfast Electric Lighting Plant (Abstract from paper of Victor A. H. McCowen read before the Inst. of Mech. Engs. Illustrated description). Pro Age—Oct. 15. 1800 w.

8776. An Air Hoist for Mercantile Purposes (Illustrated detailed description). Com Air—Oct. 600 w.

8778. Air Volumes Used in Engines (Formulae and data). Com Air—Oct. 400 w.

8779. The Application of Compressed Air to Cranes and Hoists. William Prellwitz (Illustrated description of a 20-ton travelling crane driven by compressed air). Com Air—Oct. 1200 w.

8796. The Cheapening of Farm Machinery (The present state of the farming machine industry and the extent of its aid to agriculture). Ir Age—Oct. 22. 2200 w.

8797. Experiments with Glass Bearings. George D. Rice (Illustrated description of experiments with glass bearings, which shows that while not reliable in cases of emergency, they may yet find a place for special purposes). Ir Age—Oct. 22. 1000 w.

8799. The Cost of Air Compression. Frank Richards (How it should be reckoned for the most improved compressors). Am Mach—Oct. 22. 1000 w.

8801. Ball Step Bearing and Magnetic Brake of the Sprague-Pratt Electric Elevator. (Description). Am Mach—Oct. 22. 1200 w.

8920. Rope Transmission. J. F. De Voll (Read before Ass'n No. 2, of Missouri, N. A. S. E. An entirely practical dissertation upon rope driving). Age of St.—Oct. 24. 2000 w.

8921. The Decimal System of Gauging Adopted by the American Steel Manufacturers' Association (Report of committee favoring and recommending the adoption of a decimal gauge which will measure all materials in thousandths of an inch. The form of gauge is illustrated). Ir Age—Oct. 29. 3000 w.

8936. The Bates Thermic Engine Co. (Illustrated description of a gas engine invented by M. Gardie, of Nantes, and improved by Maurice Lorois, now being exploited by the company named. Also editorial remarks and criticisms). Eng News—Oct. 22. 4000 w.

8948. The Erection of a Large Steel Stack. Fred N. Dillon (Illustrated description of the raising of one of three steel stacks of large dimensions, each stack being raised integrally and placed on its base. The one illustrated has a height of 130 ft. and a diameter of 60 in.). Power—Nov. 1400 w.

8990. Steel Gearing. R. Grimshaw (Formulae for properly proportioning and general remarks). Mach—Nov. 1400 w.

*8997. Shock Prevention in Machinery. W. H. Atherton (The various methods of preventing shock formerly used and now in use are briefly set forth, with some general remarks on each method). Mech Wld—Oct. 23. 2200 w.

9051. The Sprague Worm-Geared Electric Elevators (Illustrated description of an example of the most modern approved practice in worm gearing). Am Mach—Nov. 5. 1100 w.

†9090. Pneumatic Power Applied to Workshops. John Davis Barnett (Records the present position of air power as part of a craft, illustrated more especially by railway shop work). Trans Can Soc of Civ Engs—June. 5800 w.

9102. A High-Duty Pump for Elevator Service in Buffalo, N. Y. (Illustrated detailed description, with data of duty tests and dimension table). Eng Rec—Nov. 7. 1800 w.

†9112. The Law Relating to Accidents in Factories (Deals principally with rubber factories, but is also applicable to any factory. A compilation from legal authorities). Ind Rub Wld—Nov. 10. 1200 w.

*9113. Self-Propelled Vehicles. Sir David Salomons (Abstract of the inaugural address to the Liverpool branch of the Self-Propelled Traffic Assn. General discussion of legal, technical and practical aspects of the subject). Ind & Ir—Oct. 30. Serial. 1st part. 4,300 w.

We supply copies of these articles. See introductory.

MINING & METALLURGY

A British View of the American Iron Trade.

IT is always of interest and often of profit to realize the aspiration of the Scotch poet and "see oursels as ithers see us"; in pursuance of this desirable end, therefore, we present two views of the American iron-trade situation as estimated by British authorities.

The first is from *The Iron and Coal Trades Review*, and is an excerpt from an article entitled: "How to Recover Our Waning Trade." The paper is introduced by a strong and appreciative review of the energy, courage, and perseverance of the English trader, who is described as desiring simply "a fair field and no favor," trusting to his own powers to win the supremacy. But, viewing the existing conditions, the writer of the article does not find these primal requisites. "Free trade has not been adopted by the nations of the world, as it was expected by the Cobden school that it would be." "Great Britain stands isolated among the great industrial nations in her economic system," and herein this evidently strong protectionist writer finds her disadvantage.

In fact, he seems to see no remedy but the adoption of protection by Great Britain. Reciprocity is discussed and found wanting; the adoption of free trade, even by the United States, promises no relief. "No man who has carefully watched the recent course of industrial movements in the United States will readily admit that the adoption of free trade by that country would be likely to help England, except, at the most, in a very temporary and unstable fashion. So far as the iron and steel industries, and the collateral trades of machine-making, cutlery, and implement-construction, are concerned, we do not hesitate to say that it would not help us at all. This is a bold assertion, and twenty years ago it would have been deemed ridiculous. But many things have happened since then. In several of the principal iron-making States, the cost of producing pig-iron is considerably lower than it is in any part of Great Britain. Common labor to-day is being purchased at some of the large ironworks in Alabama and Tennessee for 17s. per shift, or less than it costs in any part of England under similar conditions. Alabama is now exporting pig iron to Europe, and is likely to continue to do so in larger quantities. American coal is now shipped to continental ports, and shippers are looking forward to a much larger business of this kind in the time to come. American machine-tools are being more and more extensively used in Europe. American locomotives are preferred to English, and are admittedly cheaper in first cost, not only on the American continent, but in Japan, Russia, and even in some of our own Australian colonies. American armor-plates and American projectiles compete with our own in many countries, and American rail manufacturers are now wresting numerous orders from their English competitors in South and Central America, Japan, and other countries. But, most significant and ominous of all, American manufacturers have captured the largest half of the Canadian markets for iron and steel, although they are not in any way favored, and they even look forward to supplying Canada with tinplates, which they are not at all unlikely to do within the next few years. The United States have cheaper fuel, cheaper labor,—always relatively to its efficiency, and sometimes in reference to its nominal value,—cheaper ores, cheaper transport, and cheaper pig-iron, than we have in Great Britain. They are likely to continue to enjoy those advantages; they mean to maintain them, and to make good use of them in the time to come. Is it likely, therefore, that we should gain much, if anything, by reciprocity with such a country as the United States? Any advantage resulting from reciprocity would be a mere flash in the pan. In a

few months, at the most, the American manufacturer would get abreast of us, and, in seeking to do this without protection, he would be the better fitting himself for that ultimate struggle between British and American industry which must henceforth be fought out without fear, favor, or affection in every neutral market throughout the wide world."

The second view is that of an editorial writer in *Industries and Iron*, who, after reviewing the condition of the American iron trade during 1895 and 1896, continues:

"Under these conditions (*i. e.*, overproduction at home) it is only natural that those producers who are within easy reach of shipping facilities should endeavor to open up a foreign trade for the purpose of relieving somewhat the heavy stocks which have accumulated. Quite a little 'storm in a teacup' was created when about April last two small cargoes of pig-iron were received in this country—at Middlesborough, if we remember rightly—from Birmingham, Alabama. The storm was, however, somewhat allayed when it was officially announced by the shippers of the iron—the Sloss Iron and Steel Company—that there is no significance to be attached to our shipment of pig-iron to England. . . It just so happened that, owing to light shipments of cotton, several vessels wanted stiffening, and we were enabled to get an abnormally low rate of freight, which allowed us to make the shipment."

"For a time nothing more was heard of American pig-iron in this country; but, in view of the downward tendency in prices and the steady increase in stocks, notwithstanding the decreased production, in America, other producers have been tempted to try their chance in the English market. The result is that the competition of American pig-iron is becoming more of a reality in districts where it can be delivered at a low cost of carriage, and considerable purchases have been made recently, chiefly forge qualities, for use in the finished-iron works in the Warrington and Wigan districts. Furthermore, the quality is reported to be satisfactory, and it is reported that one large firm of iron and steel merchants has recently imported about ten thousand tons of American pig-iron, while from New York we learn that the Tennessee Iron and Steel Company has just received an order for three thousand tons of pig-iron for England.

"It is not only in pig-iron that we are experiencing an American invasion, as it is reported that American steel rails are being offered in this country at lower rates than those demanded by English producers, while Lancashire makers of steel billets are meeting with competition, American billets being offered at about £4 per ton, delivered Warrington. Although the existing low prices in America, and the fact that all branches of the iron and steel trades in this country are just now exceedingly well off for orders, may enable a fairly large trade to be temporarily done in imported material, yet we have no fears of it becoming of a permanent character."

Neither writer can well be suspected of any bias in favor of the American trade. Their coincident and rather unexpected views will furnish food for thought, though they may be distasteful to the political world who love to talk of the "pauper labor of Europe" and to represent our manufacturers as needing the field on their side and demanding a monopoly of the favors.

Calcined Lime in the Blast-Furnace.

THE possibility of an important improvement in blast furnace practice through the use of calcined lime in place of limestone, says Mr. O. W. Davis in the *American Manufacturer*, is a topic which is exciting a good deal of interest in England, but which has received very little notice on this side of the water; and even on the other side "the real issue has been somewhat obscured by a sharp controversy over the matter of chemical reactions in the blast-furnace."

"Out of the smoke of the contest, however, certain facts have developed"; the clearest conclusions, which are at the same time the most favorable to the practice, are embodied in the report of Mr. Charles Cochrane, former president of the Mechanical Engineers, laid before that body in 1889, and "giving the results of the opera-

tion of two of his furnaces at the Ormsby Iron Works.

"These furnaces are 76 feet high, 20,000 cubic feet contents, and were run for several months alternately on raw and calcined limerock, from the latter of which about 85 per cent. of the carbonic acid of the rock had been driven off by previous calcination. The result shown was an actual saving in fuel of 18 per cent. and an increase of output of pig iron of over 14 per cent. from use of the calcined rock."

Sir Lowthian Bell disputed the accuracy of these figures on theoretical grounds; but he and others siding with him admitted "an undoubted economy in the use of caustic lime in furnaces fifty feet high and under, while denying such economy in larger stacks."

At the Belgian meeting of the Iron and Steel Institute in 1894 the question was revived, and Sir Lowthian Bell presented a paper designed to support his position. But his figures show that two of the Clarence furnaces, 80 feet high, had been run alternately for several months on raw and calcined lime, and that the average output of the furnaces was increased 10 per cent., and the fuel consumption per ton of iron decreased 8½ per cent., by use of the calcined lime. His analyses further showed that his "calcined" limerock still carried 32 to 35 per cent. of carbonic acid, only 7 per cent. having been driven off in the kilns. It appeared also that, for this exceedingly imperfect calcination, he had used about one ton of small coal to three tons of limerock at a cost of about 38 cents per ton of rock. It is not surprising therefore that Mr. Cochrane remarked: "If Mr. Bell employed such imperfectly calcined rock as to contain 31 to 35 per cent. of carbonic acid, out of a possible 42 per cent., it is no wonder that he condemned the practice."

This was about in line with the results reported by Mr. Windsor Richards, from Eston furnace experience, at the former meeting.

Mr. Chas. Wood, of Middlesborough, stated that for the past twenty-five years he had used calcined lime in his furnaces, and because he had found it had paid him to do so. He found that he "worked with less coke, got more pig iron, used less blast, and had richer gases for his stoves and boilers, than when using raw lime rock."

Mr. Davis thus sums up the conclusions.

"It appears then from the above:

"That all parties agree that in furnaces of 50 feet and under the use of calcined lime results in great economy of fuel and increase of production of iron.

"It was shown by Mr. Cochrane that in furnaces 76 feet high he secured a reduction of fuel of 18 per cent. and an increase of pig iron of over 14 per cent. by use of a limestone from which 85 per cent. of the contents of carbonic acid had been removed by previous calcination.

"Mr. Bell reports a saving of fuel of 8½ per cent. and an increased output of iron of 10 per cent. by use of a limerock from which only 7 per cent. of the carbonic acid had been extracted.

"Mr. Windsor Richards reports no saving of fuel, but an average increase of output per furnace of 11 per cent. in furnaces 80 feet high, but gives no statement as to the relative calcination of the rock.

"From the tenor of the entire discussion, it seems to be a fair inference that with a moderately well burned limerock, say, with 30 per cent. out of the 42 per cent. carbonic acid expelled, there will result a saving in fuel of not less than 12 per cent. and an increase in output of 12 per cent. or more, and consequently that the whole matter resolves itself into the cost of calcining the flux."

He rightly considers that the matter is of extreme importance to American furnace-men "in these days of low prices and small margins," especially if (as suggested elsewhere in these columns) there is actually a prospect of finding an English market for our iron, and if further, as suggested by Mr. Davis, American practice seems particularly efficient in means for cheaply calcining the limestone.

That the use of calcined lime will facilitate furnace reactions, permit of heavier burdens, and increase the output of pig (while incidentally furnishing richer gases) seems evident enough. It may seem likely

also to result in fuel economy in the furnace itself, but it is not clearly apparent why the total fuel-consumption (including that used in calcination) should show an economy.

Separate calcination seems to afford a double opportunity for loss of waste-heat and to make an individual fuel-consuming process of something which, one would think, would be accomplished naturally in the upper part of the stack.

But such speculation resembles the theoretical digression which is said to obscure the main issue on the other side. The practical results quoted certainly warrant thorough experiment in American furnaces, and actual trials will furnish the best basis for conclusions.

Mining Education in England.

THE subject of possible or evident defects in our systems of technical education has recently occupied considerable space in the journals, and has brought out rather a sharp discussion, in which severe things have been said concerning the course in mining engineering and the capability of the graduates turned out. We were doing the thing very badly, we were told, and a complete reorganization was necessary.

It may be interesting, and possibly comforting, to find that our English cousins, in the privacy of the home, say similarly hard things about their own institutions.

The following extracts are from an article on "English and Foreign Experts" in *The Mining Journal, Railway and Commercial Gazette* (London), and are offered without comment, and with the reminder that we often say things of ourselves which we would resent from others, or which, perhaps, others would not be disposed to say of us.

"No one who has followed the recent history of metalliferous mining can have failed to be struck by the very large extent to which foreign mining engineers have been given the leading position in the technical direction of mining ventures carried out by British capital. In this respect something like a revolution has taken place in the conduct of this branch of enterprise. A few years ago the financier in London who had taken up the exploitation of a mineral property would apply to an English firm of experts, and would secure the services of an accredited English engineer to report upon its prospects and value.

"Since the development of the South African gold fields, however, it must be admitted that the glory of the English mining expert has to a considerable degree departed. It is a confession which we make with considerable reluctance, but which, at the same time, in the interests of the mining profession, it seems desirable to make."

The complaint is said to be "that Englishmen did not adapt themselves to the strange conditions of working on the Witwatersrand. The college-taught expert was declared to be a compound of British pedantry and German scholasticism, with little or no practical experience and an unintelligent reliance upon inapplicable textbooks.

"It is true that there were numerous exceptions to these strictures. Some of the most successful mines on the Rand have been developed by consulting engineers who came straight from the English technical institutions, or by managers who had learned everything they knew in Cornish tin times. At the same time it is impossible to shut one's eyes to the fact that there has been, as a whole, a tendency in South Africa to supplant Englishmen as engineers and managers by Americans and Germans. At the present time the most brilliant advisory positions in both the Transvaal and Rhodesia are held by men whose training-ground has been California, and managerships are increasingly coming into the hands of their countrymen. A young Englishman with the highest testimonials who goes out to Johannesburg will find considerable difficulty in obtaining a responsible position at a mine of which the directorate is almost entirely English, and the capital of which has been entirely obtained from England. In Western Australia the same tendency is exhibiting itself with even greater force.

"It is, however, probable—and we think

most experienced English mining engineers will agree with the opinion—that the teaching in English technical institutions is a good deal more inelastic and unpractical than in the corresponding places of the United States and the continent. Students are grounded in all the details of geology and the metallurgy of the laboratory, while they are taught scarcely anything of the actual working methods of existing mining fields; and too many of them quit their college quite convinced that they are able to take up the management of any mine in the world. If there were more appreciation of the absolute necessity of studying mining itself before essaying to direct all its complicated processes, we feel confident that the present prejudice against British mining engineers would not exist amongst mining financiers.

"One very simple reform which would have a very useful effect in training our young mining engineers would be to infuse a more practical character into the papers read before our technical societies. Much has been done of late years in this direction, but a great deal more can be accomplished. Even as they are, however, English mining engineers should certainly be preferred by English shareholders to the foreign experts who threaten at present to monopolize the direction of mining. The French have set us an excellent example in this respect. In the mining companies in which their holdings are predominant they have insisted that places should be found for Frenchmen of sufficient knowledge and ability. Without sacrificing the prosperity of a company to patriotism, English shareholders might very well assume the same attitude."

If the criticisms on the educational system and its results are valid, the concluding suggestion is hardly likely to find favor with financiers or shareholders, or to result in satisfaction to anyone, if put into practice. The remedy, if one be needed, must be supplied by better engineering, not stronger patriotism. Sentiment is not an element of success in business; skill is.

Hydraulic Power for Mine-Pumping.

THE rising interest in the subject of power transmission in mines has prompted the appearance, elsewhere in the pages of this number, of a critical review of an important series of papers on this topic recently published. In general, electricity and compressed air have been regarded as the alternative agencies, with little attention to any other medium.

The *Colliery Guardian*, however, in a translation of a communication to the Société de l'Industrie Minérale (made by MM. Griot and Rodde, engineers at the Montrambert Colliery), suggest hydraulic transmission for mine-pumping. If successful for that purpose, as it is said to be it might find a wider application.

The Kaselowsky pumping engine, as it is termed, is in use at several German mines. "The principle of this system is to use water under great pressure—200 to 250 kilograms per square centimeter (mean, 3,200 pounds per square inch)—as the motive agent for the underground pumps that force the mine water to the surface in a single lift. This water under pressure is forced by pumps on the surface into the pumps underground, and again returns to the former, by steel pipes of very small diameter—60 to 70 millimeters (mean, $2\frac{9}{16}$ in.)—and, when necessary, a pipe of 10 millimeters ($\frac{13}{32}$ inches) inside diameter leads compressed air into regulating apparatus mounted on the water pipes near the pumps, for preventing ram-strokes. The water raised, which is only subjected to the pressure due to the height of the shaft, is forced to the surface in cast-iron pipes in a single lift.

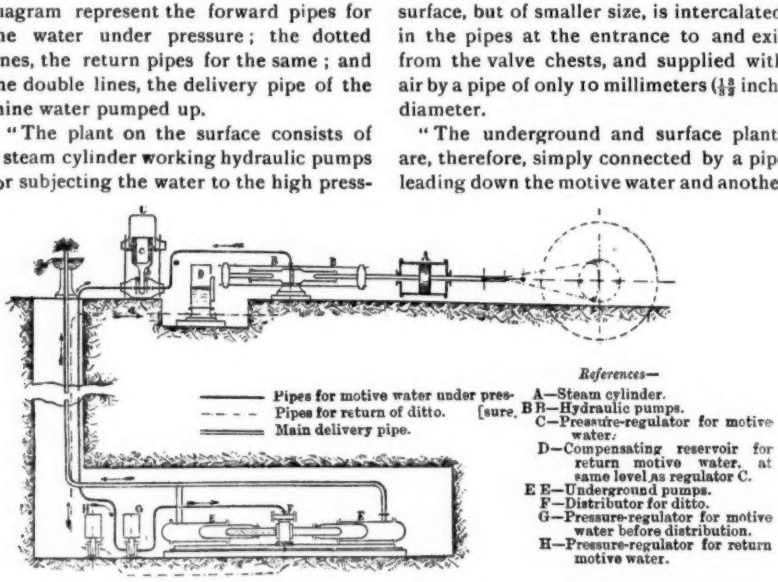
"This method of pumping, therefore, only occupies in a shaft the space required by the two small pipes, forward and return, of the motive water, the delivery-pipe for the water raised, and the small pipe for compressed air, thus leaving the shaft, though used for pumping, almost completely free for winding. The plant comprises the pumps working on the surface and those underground, a diagram of which, showing the principle of the arrangement, is given by the accompanying figure, in which A represents the steam

cylinder, B B the hydraulic pumps, C the pressure-regulator of the motive water, D a reservoir for making good any leakage of the motive water, E E the underground pumps, F their distributing valve, G the pressure-regulator of the motive water underground before being admitted to the pump barrels, and H the pressure-regulator of this water after exerting its effect in the barrels. The thick single lines in the diagram represent the forward pipes for the water under pressure; the dotted lines, the return pipes for the same; and the double lines, the delivery pipe of the mine water pumped up.

"The plant on the surface consists of a steam cylinder working hydraulic pumps for subjecting the water to the high pressure above mentioned. On leaving the pumps, this water passes into the pressure-regulator, C, which is very sensitive, for preventing ram strokes in the pipe leading the motive water to the bottom of the shaft. This regulator consists of a cylinder, *a*, in which works a plunger, *b*, for determining an increase or diminution of volume, being subjected to a constant pressure of compressed air at a lower pressure, and acting on another piston, *c*, of larger sectional area.

"The underground plant consists of a group of four single-acting pumps drawing the water of the mine and forcing it to the surface; and these four pumps are worked by the motor pistons acted upon by the water from the surface under a pressure of 200 to 250 kilograms per square centimeter (mean, 3,200 pounds per square inch). After this water has transmitted its power, it is raised to the surface, where it is again put under pressure by the hydraulic pumps. As, however, the underground pumps do not work at a uniform speed, there would be accelerations and retardations of speed in the pipes, which should be neutralized for preventing shock; and to this end a pressure-regulator, similar to that on the surface, but of smaller size, is intercalated in the pipes at the entrance to and exit from the valve chests, and supplied with air by a pipe of only 10 millimeters ($\frac{1}{3\frac{9}{3}}$ inch) diameter.

"The underground and surface plants are, therefore, simply connected by a pipe leading down the motive water and another bringing it back, besides the small air-pipe, so that the space taken up in the shaft is limited to these three pipes and the main delivery pipe."


Pipes for motive water under pressure.
Pipes for return of ditto.
Main delivery pipe.
References—
A—Steam cylinder.
B B—Hydraulic pumps.
C—Pressure-regulator for motive water.
D—Compensating reservoir for return motive water, at same level as regulator C.
E E—Underground pumps.
F—Distributor for ditto.
G—Pressure-regulator for motive water before distribution.
H—Pressure-regulator for return motive water.

The return of the motive water is considered of importance, both because it saves the lubricant with which the water is impregnated, and because mine-waters are often acid or muddy, and likely to cause incrustation or corrosion. Glycerine is used to prevent the water from freezing in cold weather: the pumps are said to work drowned without difficulty, and the loss in transmission to be reducible to "a few units."

Early Experiences with Fire-Damp.

UNDER the title, "Annals of Coal Mining and the Coal Trade," the *Colliery*

Guardian has been publishing a very interesting and often amusing historical review of the working of British collieries. With the deeper working of the seams began the trouble. The damp was first heard of in 1640, in the Mostyn colliery.

"After they had gone a considerable distance underground, and were in want of fresh air, the fire-damp gradually began to 'breed.' At first the workmen made but a sport of it, toying with it with their lighted candles, till one morning 'the first collier that went down, going forward in the witchet with his candle in his hand, the damp presently darted out so violently at his candle that it struck the man clean down, singed all his hair and clothes, and disabled him from working thereafter.'"

"In consequence of some warnings of this sort, the colliers selected one of their number more resolute than the rest—a man of purpose—to go down into the mine some time before them every morning to fire, or explode, the small accumulations of the gas. Clothing himself with the worst rags he had, saturated with water, this individual—subsequently known as the 'fireman'—advanced towards the places where fire-damp was supposed to exist, and, crawling forward, held a long pole before him with one or more lighted candles at its end. This ignited the fire-damp, if present, and produced an explosion of more or less violence, according to the quantity of gas accumulated. As the flame ran along the roof, the fireman lay flat on the floor of the mine till it passed over him. When his operations had been completed, the rest of the colliers entered the pit, and the motion of the air caused by their working prevented the gas from collecting during the day.

"This is the earliest account we have of this primitive method of dealing with fire-damp, which may be termed the firing system, and which was subsequently practised in many of the coal-fields when difficulties with the gas had become more general. It is spoken of as 'the ordinary way' by Professor Sinclair in 1672 (*Hydrostatics*, p. 294), and we have records of its being pursued at a later date in Shropshire, Staffordshire, Leicestershire, Lancashire, and Cumberland."

And in 1675, in these same workings at Mostyn, occurred a terrible explosion, by which the body of one of the victims, blown up the pit, was carried thirty-five yards into the air above its mouth.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

METALLURGY.

8688. Formulas for Determining the Value of Iron Ores. G. Teichgraber (Translated from "Stahl und Eisen." The formulas for the different elements affecting the cost of pig iron are worked out). Eng & Min Jour—Oct. 10. 900 w.

8691. Shall We Use Calcined Lime in the Blast Furnace? O. W. Davis (Facts developed from the discussion of this subject in England). Am Mfr & Ir Wld—Oct. 9. 1500 w.

8692. Blast Furnace Scaffolds. E. Bernard (Communication made to the Engng Assn of the Liege School, translated by H. H. Stoek. The writer thinks it possible to explain scaffolding simply by the method of fusion of blast furnace slags). Am Mfr & Ir Wld—Oct. 9. 1400 w.

*8695. Metallurgy of Gold. H. Van F. Furman (Its occurrence, its properties and metallurgical processes for extracting it from ores. Crushing and pulverizing machinery; amalgamation methods; concentration; chlorination and bromination; the cyanide process, smelting process, new methods; melting, assaying and parting gold bullion). Col Eng—Oct. 6000 w.

8736. Standard Specifications for Structural Steel (The text of the specifications adopted by the American Steel Mfrs). Ry Rev—Oct. 10. 1800 w.

8737. A Cheap Cyanide Plant. M. A. Knapp (Description of a small and successful plant constructed at Hawthorne, Nevada). Min and Sci Pr—Oct 10. 1100 w.

*8750. The New Basic Steel Manufacturing Process (Description, with editorial comment, of the patent of B. P. Stockman, by the use of which it is claimed that Cleveland or other iron not now available for steel making may at small expense be converted into steel which shows excellent analysis and answers to required tests). Ir & Coal Trds Rev—Oct. 9. 2200 w.

*8783. Steel. Robert Carr Lanphier (The essential features of steel, methods of producing it, its properties, &c.) Yale Sci M—Oct. 2500 w.

We supply copies of these articles. See introductory.

8794. Recent Developments and Standards in Armor and Heavy Ordinance. W. H. Jacques (Read before section G of the British Assn., Liverpool. A review of the progress made, with examination of tests made in various countries. The record is most satisfactory). Ir Age—Oct. 22. 2000 w.

8881. A New Gold Saving Process. Dr. P. Langhammer (Describes the process; the main point is that the gold does not and must not come in contact with water until it reaches the chemical solution). Min and Sci Pr—Oct. 17. 1500 w.

8882. A Hot Blast System for Copper Matting and Silver-Lead Furnaces (From advance sheets of a treatise on this subject by J. W. Nesmith. Illustrated description). Min and Sci Pr—Oct. 17. 3000 w.

*8904. The MacArthur-Yates Process of Gold Extraction, Dry Crushing, with Direct Amalgamation and Cyanidation. John Yates (From a paper read before the Federated Inst. of Min. Engs. Describes process, which is, in the main, the ordinary cyanide percolation process, the distinguishing feature being that the ore is subjected to a short preliminary agitation with the view of securing the amalgamation of as much of the gold as possible, and then raising the extraction). Min Jour—Oct. 17. 900 w.

*8905. The Electrolytic Desilverization of Argentiferous Lead by the Tommasi Process. Dr. D. Tommasi (The principle upon which this process is based is stated, apparatus used is described, also advantages and working cost). Min Jour—Oct. 17. 1600 w.

8910. American Blast Furnace Practice (A reply to the statement made by John L. Stevenson, in "The Engineer," London, that the methods used in this country have not been very successful when adopted in England. Followed by illustrated description of furnace which has given excellent results). Am Mfr & Ir Wld—Oct. 23. 900 w.

8911. The Cyanide Process in the United States (Editorial review of the progress and success of this process). Eng & Min Jour—Oct. 24. 1500 w.

8913. On the Chemistry of the Cyanide Copper Assay. J. J. Beringer and H. W. Hutchin (A discussion of the conditions which affect the results in this process). Eng and Min Jour—Oct. 24. 1000 w.

*8952. Best Yorkshire Iron, and How It Is Made. E. Windsor Richards (An address at the opening of the metallurgical department of the Glasgow and West of Scotland Technical College. History of Lowmoor Iron Works, with a description of the methods adopted there). Eng, Lond—Oct. 16. 4700 w.

9030. Dr. Emmons's Transmutation of Silver into Gold (Letter from Stephen H. Emmens in reply to statements made by Prof. E. M. Endlich). Eng and Min Jour—Oct. 31. 1000 w.

†9044. On the Diffusion of Sulphides Through Steel. E. D. Campbell (Describes experiments selected from 40 diffusion tests, giving possible explanation of observed phenomena). Am Chem Jour—Nov. 4000 w.

†9045. On the Influence of Heat Treatment and Carbon upon the Solubility of Phosphorous in Steels. E. D. Campbell and S. C. Babcock (Researches undertaken with a view to determine whether chemical evidence could be obtained to prove that phosphorous may exist in steel in two forms). Am Chem Jour.—Nov. 1100 w.

9083. Alloys and Amalgamation of Gold. H. Van F. Furman, in the "Metal Miner." (A summary of the effect of small amounts of impurities on gold bullion). Min & Sci Pr—Oct. 31. 900 w.

†9118. The Direct Method Considered as the Future Metallurgical Treatment of Copper Ores, Argentiferous or Otherwise. Christopher James. (Full paper as read before the Inst. of Min. & Met., London. A complete account of the new process, with a condensed view of the old Welsh method of copper smelting, together with the variations which Continental practice and American practice have superimposed upon the old method). Inst of Min & Met, London—Oct. 19000 w.

*9123. Chemical Changes Involved in the Extraction of Metals from Their Compounds. J. M. Thomson (Extract from a paper read before the Soc. of Arts. An examination of the chemical changes taking place in the various processes). Col Guard—Oct. 30. 1500 w.

MINING.

*8697. The Cripple Creek Region. Arthur Lakes (Epitome of the United States Geological Survey's report on the Cripple Creek mining region, simplified and prepared for mining men). Col Eng—Oct. 5000 w.

*8698. Lead and Zinc. A. G. Leonard (A description of the mines of Iowa in the upper Mississippi region, with illustrations. The mode of occurrence of the ores, the minerals associated with them and the theories in regard to their deposition, with a description of some of the mines). Col Eng—Oct. 2300 w.

*8699. The Mining and Treatment of Coal (The first part treats of the washing of coal.) Ir and Coal Tds Rev—Oct. 2. Serial. 1st part. 1200 w.

*8700. The Geology of Africa in Relation to Its Mineral Wealth. Walcot Gibson (Abstract from a paper read before the Federated Inst. of Min. Engs. Brief sketch of African geology). Min Jour—Oct. 3. 2800 w.

*8714. Coal Pit Sinking in South Wales (Extract from address of Henry W. Martin before the South Wales Inst. of Engs. Describes method of rapid sinking, with illustrations). Ir and St Trds Jour—Oct. 3. 2000 w.

*8747. Gold in Chile. B. Becker (Part first briefly reviews its value as a producer in former centuries, and describes the country geographically, geologically and commercially). Min Jour—Oct. 10. Serial. 1st part. 1100 w.

8748. New Zealand Prospects (Editorial reviewing the bright prospects of this colony). Min Jour—Oct. 10. 1400 w.

*8760. The Sterlingshire Coalfield (Part first is a description of Bannockburn Colliery, which is laid out on the most approved principles for the saving of labor, separation and easy handling of coal, and dressing it for the markets). Col Guard—Oct. 9. 2800 w.

*8892. Improvements in Prussian Mining Methods (Experimental trials in wedging are explained and illustrated, with improvements in other methods of mining work). Col Guard—Oct. 16. Serial. 1st part. 2500 w.

*8896. Wallsend Coal (Account of work being resumed in collieries that have not yielded for nearly fifty years. Work was stopped, as the pumping appliances of that day were not adequate. Improved machinery has made working again possible). Col Guard—Oct. 6. 700 w.

*8897. Installation of a New Metal Guiding Apparatus (Briart System) Marc Warolus (translated from Revue Universelle des Mines, &c. Description of apparatus which was installed in No. 4 pit of the Monceau Fontaine and Martinet collieries). Col Guard—Oct. 16. Serial. 1st part. 2300 w.

*8898. The Grand Lake Coal Field of New Brunswick. R. G. E. Leckie (Its location and distribution, quality and quantity). Col Guard—Oct. 16. 1500 w.

*8899. Anthracite Coal Breaking and Sizing Plant, at Glyncastle Colliery. W. D. Wight (Read at the meeting of the Federated Soc. of Min. Engs. at Cardiff. Illustrated description). Ind & Ir—Oct. 16. 2200 w.

8918. Minerals of Cascade County. O. C. Mortson (The deposits in this part of Montana are essentially economic, such as coal, iron, fire clay, building materials, &c. The precious metals have not yet been found). W Min Wld—Oct. 24. 2200 w.

*8919. A New Mode of Sinking Shafts. From the "Federated Institute" (Describes the freezing process of shaft sinking; the advantage of the direct freezing method). Aust Min Stand—Sept. 17. 2300 w.

8975. The Development of Colorado's Mining Industry. T. A. Rickard (Review of its history from 1849 to the present). Min & Sci Pr—Oct. 24. 2800 w.

9082. Copper Deposits in Sonora, Mexico. I B. Storch (Information relating to the large deposit of copper ore in the mountain range Sierra de Canoneas). Min & Sci Pr—Oct. 31. 800 w.

9106. Future Gold Fields—Guiana. Charles E. Clarke (Considers the territory lying east of the Schomburgk line to be one of the great auriferous fields of the future). Eng and Min Jour—Nov. 7. 2500 w.

*9114. Chilian Nitrate of Soda Deposits (Gives an historical account of the discovery, how long known, the methods of mining, value, &c.). Engng—Oct. 30. Serial. 1st part. 2500 w.

*9121. The Use of Compressed Air in Canadian Mines (R. H. Brown and Charles Fergie contribute brief papers on this subject to the Canadian Mining Inst. Describing pumping by compressed air in Nova Scotia mines). Col Guard—Oct. 30. 2200 w.

*9126. Standing Tree-Trunks in a Liege Colliery. G. Schmitz in a communication to the Academie Royale de Belgique. (Facts which the writer thinks call for a fresh examination of opinions hitherto advanced regarding the formation of coal from vegetation in the very spot where the trees grew). Col Guard—Oct. 30. 900 w.

*9127. The Transvaal Coal Field. W. Forster Brown (Read before the South Wales Inst. of Engs. Review of the physical and geological features, quality, system of working, markets, &c). Col Guard—Oct. 30. 3000 w.

*9140. The Mineral Resources of Arizona. Thomas Tonge (Shows Arizona to be rich in minerals and reviews the development in the different countries). Min Jour—Oct. 31. 2000 w.

MISCELLANY.

*8690. Calculating Guibal Fans with Single Inlet. Emile Gosseries (Experiments made with the Guibal fan lately put up at the Sacre-Madame Colliery, Charleroi). Col Guard—Oct. 2. 2400 w.

*8696. Calculating the Friction of Haulage Ropes. C. F. Scott (From an article in the Journal of the Society of British Mining Students. Mathematical). Col Eng—Oct. 1000 w.

†8711. A new and Important Source of Phosphate Rock in Tennessee. James M. Safford (Describes the rock, which is Trenton, and is the result of long-continued leaching of the rocks by atmospheric and aqueous agencies). Am Geol —Oct. 1000 w.

*8740. Central Maryland Granites. Charles Rollin Keyes (Condensed from the fifteenth annual report U. S. Geological Survey. Some of the problems encountered in the study of these rocks, their classification, types and components.

Illustrated). Stone—Oct. Serial, 1st part. 2400 w.

*8741. On the Influence of the Diameter of Holes in Blasting Operations. James Ashworth (From "Colliery Guardian" experiments proving that a great difference in results is obtained by the mode of application, and that correct understanding of the subject is necessary to safety). Stone—Oct. 1100 w.

*8757. The Testing of Coals. Arthur Winslow (A plan to conduct a study of North American coals to furnish information of uniform reliability is outlined). Jour Assn of Eng Soc—Sept. 2400 w.

*8759. Mine Pumping with Hydraulic Transmission of Power. M. Griot and M. Rodde. (From a communication to the Societe de l'Industrie Minerale, Saint-Etienne. Description of Kaselowsky pumping engine, its principle, method of pumping, plant on the surface and under ground, with examples of working in different plants. Col. Guard—Oct. 9. 2800 w.

*8761. The Production, Value and Distribution of Coal in 1895. (Statistics from the report relating to the mineral industry of the United Kingdom). Col. Guard—Oct. 9. 1500 w.

8876. Iron in New South Wales. (Some facts and figures regarding the iron deposits and iron works in country named). Eng News—Oct. 15. 1000 w.

*8893. Interesting Boring Operations at Ilkeston. (A brief account of boring for a supply of water for the borough). Col Guard—Oct. 16. 900 w.

*8894. Iron Ore Mining and Pig Iron Production. (From the "Mineral Statistics of the United Kingdom" for 1895. A general summary of the production during 1895 and the quantity and value of pig iron). Col Guard—Oct. 16. 1400 w.

*8895. Co-Ownership of Coal Mines (Leading aspects and essential points of the question). Col Guard—Oct. 16. 2400 w.

8901. Story of Death Valley. (Review of a book by William Lewis Manly, "Death Valley in '49." The writer was one of the party who made the eventful journey). Min Ind & Rev—Oct. 22. 3000 w.

*8932. The American Iron Industry (Extracts from an article written by James M. Swank, and published in the Annual Report of the Association for 1895. Reviews the progress of the iron and steel industries from the middle of the 17th century, calling attention to the effect of the protective policy upon iron making in this country since 1860). Gunton's Mag—Nov. 2400 w.

†8963. The Production of Iron Ores in 1895. John Birkinbine (A summary of the production in the United States from 1889 to 1895 is given, the quantities of different classes of iron ore produced, production by States, and other important information). 5000 w.

*9002. Coal Cleaning Machinery at Aberamman Colliery (Illustrated description). Eng. Lond—Oct. 23. Serial, 1st part. 900 w.

*9016. Some Pressure Effects Shown by Colliery Explosions. James Ashworth (Comment on Dr. Haldane's paper, with especial reference to his statement that the pressure exerted by a colliery explosion is not excessive). Col Guard—Oct. 23. 2200 w.

*9018. The Electric Ignition of Blasting Explosives (Article from a recent issue of "Arms and Explosives," special reference being made to the part played by Mr. Frank Brain, of the Electric Blasting Apparatus Company, Cinderford, in the introduction of electric blasting to mining operations). Col Guard—Oct. 23. 2200 w.

*9021. The Use of Compressed Air in Mining and Metallurgical Operations (A brief estimate of the position of compressed air at the present time. Illustrated). Ir and Coal Trds Rev—Oct. 23. 1000 w.

9053. The Racing River Gold Region (Describes its location, discovery and value, giving information regarding its prospects). Ir Age—Nov. 5. 1600 w.

9081. Needed Mining Laws (Proposed mining laws for remedying the defects that exist in California, with editorial comment). Min and Sci Pr—Oct. 31. 6500 w.

*9088. The Valuation of Prospects. Howard West (Responsibility of prospectors, and points of interest).Can Min Rev—Oct. 2500 w.

*9089. Canada as a Field for Mining Investment. Dr. G. M. Dawson (From the "National Review." The mineral resources of the country and their prospective values). Can Min Rev—Oct. 4500 w.

9107. The Coke Works and Briquetting of Mineral Coal in Austria. R. Helmhacker (Some particulars of a successful industry). Eng and Min Jour—Nov. 7. 900 w.

9108. Production of Pig Iron in France and in the World. H K. Landis (Statistics from an article by M. Pourcel with notes. Tables and diagram). Ir Tr Rev—Nov. 5. 350 w.

*9122. The Analysis of Coke. George C. Davis (Describes methods for determining the percentage of sulphur and the amount and composition of the ash). Col Guard—Oct. 30. 1200 w.

*9124. Recent Explorations for Coal in Siberia. Gen. Venukoff (Translated from "L'Echo des Mines." An account of the principal groups of coal mines already discovered in those districts of Siberia through which the railway runs). Col Guard—Oct. 30. 1300 w.

*9125. The Production of Pig Iron. From the London "Times" (The improvement in this industry in Great Britain, calling attention to prominent features of progress). Col Guard—Oct. 30. 1800 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

The Future of Calcium Carbid and Acetylene.

TAKING the ultimate price of calcium carbid at about $50 per ton, which, in his Cantor lectures on applied chemistry before the Society of Arts, he deems probable, Mr. James Swinburne thinks he can perceive a possible and even probable commercial future for the industry.

For the enrichment of gas he evidently thinks its use as yet improbable, because this use cannot be demonstrated to be profitable at any price at which the carbid seems likely soon to be supplied. The competition of acetylene with gas for general illuminating purposes he regards as at present highly improbable, especially since the illuminating power of gas has been so materially increased by the Welsbach mantle.

The distribution of acetylene to houses is one of the serious problems connected with its future. The delivery of the carbid to houses to provide consumers with the material for generating their own acetylene (all that is needed being the addition of water), says Mr. Swinburne, "sounds very simple"; but, as pertinent to this proposition, the early history of illuminating gas and of electric lighting is cited. A touch of humor seasons the good sense of the lecturer's remarks on this point.

"In the beginning of the century, coal gas was to be made on the spot in the same sort of way. All you did was to put coal into a retort, and heat it, and off came the gas. Yet this was never practised, except in special cases; and gas never came into use generally, until it was distributed by pipes ready for consumption. There are, of course, a few country houses and isolated establishments where they make a fluid they call illuminating gas. Exactly the same thing happened with the electric light. Each house was to have a gas-engine and a dynamo, and generate its own power. Then the next idea was that the accumulators were to be left at the houses with the milk, and changed next day, week, or month. But this never came into practice.

"These two schemes correspond very fairly with those of distributing carbid for use in generators, and distributing liquid acetylene in bottles. The generators would always be troublesome in an ordinary house. No doubt the light would be much cheaper and better than that of gas, as commonly used; but that is by no means everything. People forget that the average households are controlled by women. Women may understand people, but they are completely wanting in the faculty of understanding things; and they have the unreasoning conservatism and conventionality belonging to the undeveloped mind as seen in boys and savages. A woman hates everything new, and would never understand how to work an acetylene generator until it had been in use for generations, and it was considered part of the duty of a good housekeeper to make good acetylene, as it used to be to make good beer. Of course, even then it would be done by rule-of-thumb. There is more than this. The first thing a woman asks, when she sees anything new, be it a mousetrap or a telephone, is: 'Will it explode?' Now, no one can say on his honor that an acetylene generator will not explode. He does not thing it will—in fact, he feels sure it will not, and he sincerely hopes it will not; but an explosion might possibly occur. This settles the matter. The only thing to be done would be to utilize a woman's instinctive hero-worship and belief in authority, and to arrange that acetylene generators should be recommended by her clergyman or her doctor. I say *her* doctor advisedly, as she does not believe in other women's doctors.

"The plan of distributing liquid acetylene in iron bottles sounds more promising, as very little goes a long way, and the bottles could be connected to the house-service by the acetylene company without

the women of the house having anything to do with the matter."

As acetylene has not to compete with ordinary illuminating gas alone, but must also reckon with the Welsbach incandescent mantle, and as the latter requires no attention till it requires replacing, after a considerable period, acetylene, though it is a much more powerful illuminant, is handicapped beyond hope,—at least, for the near future.

Notwithstanding these facts, a large opening for acetylene is indicated apart from competition with coal gas. Mr. Swinburne thinks that "for country houses, carriages, omnibuses, railway trains, and on shipboard, it ought to have its own way." A good portable lamp for its use is a yet unrealized desideratum. Distribution in bottles is regarded as the safest and most convenient method.

"Too much has been generally said about the poisonous nature of acetylene. Experiments show that it is not at all a serious poison; and its smell is a great safeguard. It uses so little air in burning that, on the whole, it would be a very much more healthy illuminant than gas, oil, or candles, especially if it contains no sulphur. Healthy breathing is not generally sufficiently appreciated yet. Many people still sit in close rooms, and sleep with their windows shut; and the smaller air-consumption of acetylene would not really appeal to them very much."

Incandescent Gas Lighting in Paris.

THE city of Leicester, in England, is studying the improvement of street-lighting. Supplied with both gas and electricity, it has been a moot question which could be used to the best advantage in effecting the improvement desired. In order to form a better judgment, a deputation of the lighting committee of Leicester, accompanied by the corporation engineer, visited Paris to observe what is the state of the art in the French capital.

The Gas World (Oct. 10) publishes an interview with Mr. Colson, the engineer referred to, in which the results of the observations of the committee are stated and summarized.

Until recently "many of the main thoroughfares of Paris were lighted by electric arc lamps, but about two years ago the municipality, with a view to obtaining as much light at less cost, resolved on an experiment with 1,442 incandescent gas-burners. These were distributed mainly in the Place de la Concorde, the Champs Elysées, and the Place du Palais Royal. In the Place de la Concorde and along the Champs Elysées the lamp columns are placed at distances varying from about 15 to 25 yards apart, and they carry mainly single lanterns, in each of which are fixed two burners, each consuming 3½ cubic feet of gas per hour, or 7 cubic feet the pair. In the Place du Palais Royal the lamps, with a single burner in each, are clustered four or five on each post. At 15 candles per foot (the illuminating power generally obtained from this description of burner) the amount of light from each lantern is a little over 100 candles; but a higher efficiency than this is claimed by the use of the chimney employed, consisting either of ribbed glass or glass staves. The burners are not provided with a by-pass, the lighting being effected by a torch applied to the mouth of a tube projecting through the top of the lantern, which, being practically a continuation of the chimney, allows gas to pass to the end of the tube, upon opening the gas tap, and so affords means for lighting the burner. To prevent the mantle being damaged by vibration the burners are fixed on steel springs, while the strong draughts in the lantern are overcome by means of baffles. Of the general effect of the light given by the Auer-Bec system here described Mr. Colson speaks in terms of high praise. He found that at any point between the lamps ordinary print could be read with the greatest ease. Very marked, too, was the absence of the somewhat ghastly hue so frequently associated with the Welsbach light as seen in England, the improvement in this respect being obtained by the chimney that is used. Only one place in Paris was seen lighted with incandescent electric lamps, —*viz.*, the small square within the Palais Royal,—and there the light, while costly,

was anything but effective. There are only some three or four prominent places in the center of the city now lit by arc lamps. The Place de l'Opéra and the gardens of the Tuileries are so lighted, but the contrast observable as you walk from one of these places into, say, the Place de la Concorde is not strikingly in favor of street-lighting by gas. Mr. Colson thinks that gas engineers and lighting committees who have the question of street-lighting under consideration would do well to see lights in Paris," from which we infer that Paris is now setting the pace for street lighting.

In connection with the above summary, some remarks by M. Henri Marechal, gas engineer of the Paris municipality, and author of a work, "The Lighting of Paris," are quoted from an article contributed by him to *Le Génie Civil*.

M. Marechal therein says that "the Auer-Bec of 115 liters, when applied to public lighting, gives three times as much light as the butterfly burner of 140 liters. At what cost is this increased lighting-power obtained? The duration of the mantles is a most important point, as they are still high-priced. The results of a twelve months' careful observation prove that the extent of the breaking of the mantles varies with the care exercised in placing the shade, the manner of lighting, the skill of the lighter, &c. The average life of a mantle is about 68 days: this represents, therefore, an annual outlay of 5.37 mantles per burner. The saving otherwise realized is quite sufficient to pay for breakages of mantles and glasses and to provide against accidents. The substitution of the Auer-Bec for the butterfly burner has therefore resulted in three times more light without increasing the annual charges for maintenance."

With reference to the arc lamp, M. Marechal adds to the above that "the arc lamp is still more advantageous than the Auer-Bec, but it must not be forgotten that, where electricity has been installed, a great increase in the annual expense of lighting has followed. With the Auer-Bec, however, the lighting of ordinary streets is materially improved without any extra cost being incurred for maintenance. Lighting by incandescent gas for public thoroughfares seems, therefore, to be the most economical system. It is evident, too, that the light will be greatly improved in the future. Experiments are taking place on all sides which will doubtless result in the general adoption, at a cheap rate, of a light worthy of Paris."

Pumping Plants for Water Works.

THE installment of a pumping plant for a municipal water-supply may often cost far less at the outset than the necessary conduits for bringing water from a source whence it will derive sufficient pressure from a natural head. But, when installed, a pumping plant is a constant source of current expense, which, in many cases, amounts to much more than the interest upon the cost, and deterioration, of a pipe-line; so that a pipe-line, costing several times as much as the pumping plant, may yet be more economical. Such has been the decision of the city council of Leeds, England, which now proposes to substitute reservoirs, pipe-lines, and filtering-beds for its present pumping appliances.

The daily water consumption of Leeds was about 4,500,000 gallons in 1866. It is now 15,000,000 gallons, and is increasing at the rate of about 1,000,000 gallons a year. As some thirty miles of pipe-line will be required to obtain an adequate supply, including sufficient storage capacity, and as only three miles of this pipe-line will be necessary to avoid pumping, it has been decided to abandon the pumping wholly and permanently. In coming to this decision, said a member of the council (reported in the *Journal of Gas Lighting*, Oct. 13), the committee of the council was influenced by the ever-increasing cost of pumping, and their desire that pumping should be abolished for all time, seeing that the only necessary work additional to what must in any case be done to abolish this pumping forever was some three miles of pipe-line, valued at £12,000 to £14,000; whereas the cost of continuing pumping would certainly be nearly £5,000 per annum.

Incineration of Garbage.

AT the annual meeting of the Sanitary Inspectors' Association Dr. Spottiswoode Cameron and Mr. George Darley gave a statement of the cost of running the refuse-destructors at Leeds, which is a valuable addition to the current literature of the subject. These data are presented in tabulated form below. There are four destructors now in use in Leeds; one of these having been recently put into operation, the data are confined to the three destructors that have been working pretty steadily for about three years, although amounts, at the same rate, to 1.27d. Four per cent. is reckoned too high for the land. Two per cent., substituted, reduces the cost to almost exactly two shillings per ton. In tabulated form it is

	Per ton. d.
Working, less returns.....	19.52
Buildings and plant, interest, four per cent.....	3.85
Land, interest at four per cent.....	1.27
	24.64

The destructors have of late been more costly, and the land varies also in value.

Experiments on work done by destructor cells at Leeds, by Messrs. Durley and Putman. Area grate, each cell 7ft. by 5ft.; jets, two; pressure, 60 lb. Wages at rate of " for eight hours.

Date.	Number of cells.	Duration of experiment.	Diameter of steam jets.	Frequency of clinkering.	Tons burnt.	Temperature of flue.	Men employed.	Wages of firemen.	Per cell, day. Tons burnt.	Per cell, day. Men employ'd	Per cell, day. Wages paid.	Cost per ton, burnt. Wages. Pence.	Clinker per cent.
1894.				Hours.		Fah.					s d.		
June 12th.	4	12 hours.	½in.	Every 2.	20·4	1500 deg.	3	15s.	10·20	1·5	7 6	8·82	36 5
June 13th.	4	12 ,,	No jets.	,, 2	16·5	1050 deg	3	15s.	8·25	1·5	7 6	10·91	35 5
June 25th and 26th.	4	24 ,,	½in.	,, 1.	63 1	Frequently 2000 deg., *i.e.*, melted copper.	12	60s.	15·78	3	15 0	11·41	35·4
June 26th and 27th.	4	24 ,,	½in.	,, 1.	60·15	Ditto.	12	60s.	15·04	3	15 0	11·97	32·2
June 27th and 28th.	4	24 ,,	½in.	,, 1.	54·35	1500 deg.	12	60s.	13·59	3	15 0	13 25	37 0
June 28th and 29th.	2	24 ,,	½in.	,, ½	53 5	Frequently 2000 deg	12	60s.	26·75	6	30 0	13·46	35 9

never yet worked up to their full capacity.

The paper in which these data were presented was printed at length in the *Sanitary Record* (Oct. 9). The system as carried out under the direction of weighmen solely responsible to the superintendent of the refuse-removal department has enabled the department to obtain data very closely approximating accuracy.

During the three years in which the destructors have been at work, 181,645 tons of garbage have been burned. The actual cost of cremation, excluding interest on land, deterioration, and salaries of the superintendent and his staff, has been, for the time and quantity named, £14,773, which gives a mean rate of 19.53d. per ton. The interest on the cost of buildings, at four per cent., amounts to about 3.85d. per ton. The interest on the cost of land for the time and quantity specified The cost of working the destructors has also varied.

"At Arnley road the total cost for the three years, estimated in the same way, was 23.56d. per ton burned. The item of working expenditure was 18.91d. Adding the interest on the capital spent on the plant (but exclusive of land) up to 25th March, 1895, it comes to just under 21.94d., and, including land, to 23.56d. per ton.

"At the oldest of the three destructors the total cost during the three years, including interest on capital, and everything except superintendence, was at the rate of 28.54d. per ton. The working cost, exclusive of capital, was 22.65d., and, including the capital on buildings only, 27.56d. This destructor has not been fully worked, as a portion of the less offensive refuse that would otherwise have been incinerated there has been used on parts of the public

parks for filling, where it was desirable to raise the land by soil-making material. This accounts for the increased cost of destruction per ton at this station.

At the newest of the three destructors (Kidacre street) the expenses, exclusive of capital, were 17.98d. per ton, as against 22.65d. at Beckett street, and 18.91d. at Arnley road. The costs at the three destructors are tabulated as follows:

	Arnley Road. Pence per ton.	Beckett St. Pence per ton.	Kidacre St. Pence per ton.
Working, less returns	18.9111	22.651	17.983
Interest, 4 per cent... on plant	3.024	4.943	4.090
Interest, 4 per cent. on land...	1.624	.945	1.052
Totals...	23.559	28.539	23.125

The destructors are capable of burning a much larger amount than they now actually consume. It has been found that, when ten tons per cell are burned per day, the fireman's wages cost is reduced to less than 9d. per ton.

The data of experiments, which show variations in wages cost per ton as related to amount daily burned in each cell, are shown in the table herewith presented.

Explosive Nature of Acetylene.

IT seems certain that acetylene, whether used for illumination by itself or as an enricher for ordinary illuminating gas, must be handled with caution. Recent disastrous explosions, some account of which will be found in our department of Scientific Miscellany for this month, have demonstrated the fact that explosions of acetylene may occur from causes that, at present, can only be guessed at.

The French *savants*, Berthelot and Vieille, have been experimenting to ascertain the needed precautions for storing and handling this material in a commercial way, and have published some notes upon the subject in the *Comptes Rendus*. They found that, whether ignited by the electric spark, by mercury fulminate, or by a heated wire, the decomposition of acetylene under normal atmospheric pressure extends only to a short distance; but, if the gas be compressed, the extent of the decomposition, and the consequent violence of the explosion, increase in a ratio much exceeding that of the increase in pressure. Even at two atmospheres the decomposition is complete. This will have to be taken into account by all who are scheming to compress the gas into iron bottles for general commercial distribution and use. M. Pictet, one of the most experienced and skilful manipulators of compressed and liquefied gases in the world, has already had a man killed and a part of his works in Paris destroyed by the explosion of acetylene in a tank such as is used for conveying liquefied carbonic acid, and which was of enormous strength.

THE British Royal Commission declares the new red sandstone to be the most effective filtering material known, every trace of organic matter being converted into innocuous compounds. Its extent in England and Wales is 10,000 square miles. At Liverpool, four public wells yield an unvarying quantity of 6,000,000 gallons of water daily, of a quality which has remained uniform since 1851. At Nottingham and at Wolverhampton waterworks individual wells yielded over 3,000,000 gallons daily for a long period.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

GAS SUPPLY.

8670. Observations on the Construction and Working of Regenerator Settings. W. J. Jenkins (Read before the Eastern Counties' Gas Managers' Assn. The diversity of retort settings, advantages and disadvantages of different methods, practical considerations and useful modifications). Am Gas Lgt Jour—Oct. 12. 4400 w.

9034. The Bunsen Flame. Dr. W. H. Birchmore (Studies of the properties of the Bunsen flame, comparison with those of the flame of the Welsbach burner and an account of two series of experiments with a burner in which supply of gas and air were under perfect control). Am Gas Lgt Jour—Nov. 2. 4800 w.

9035. The Address of President Humphreys (A discursive but exceedingly

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practical address, for the most part dealing with administrative problems). Pro Age—Nov. 2. 11000 w.

9036. A Discussion of Various Methods Employed in the Introduction of Gas Stoves. Charles H. Nettleton (Read at the St. Louis meeting of the Am Gas Lgt Assn. Facts and practices in relation to the use of gas stoves, particularly gas cooking stoves). Pro Age—Nov. 2. 7000 w.

9037. Inclined Retorts Up to Date. Frederick Egner (Read at the St. Louis meeting of Am Gas Lgt Assn. Causes of failures in the use of inclined retorts and the success which has finally been achieved by the system. Illustrated). Pro Age—Nov. 2. 7500 w.

9038. The Separation of Water Gas Tar. Alten S. Miller (Read at the St. Louis Meeting of Am Gas Lgt Assn. Outline of a simple and inexpensive method of separating oil residuum or tar from the water as it comes from the scrubbers). Pro Age—Nov. 2. 1000 w.

9039. A Modern Retort House. William S. Miller (Illustrated description of No. 5 retort house of the Cincinnati Gas Light and Coke Co). Pro Age—Nov. 2. 5000 w.

9040. Some Experiments in Interior Illumination. C. H. Page, Jr. (Illustrated description of photometric tests). Pro Age—Nov. 2. 1200 w.

SEWERAGE.

8677. Shipley Run Sewer, Wilmington, Del. T. Chalkley Hatton (Illustrated description). Eng Rec—Oct. 10. 1500 w.

STREETS AND PAVEMENTS.

*8660. The Importance and economy of Pavement Maintenance. S. Whinery (Showing that municipal pavements should be protected properly and repaired promptly under the supervision of responsible contractors). Eng Mag—Nov. 3800 w.

*8764. Sketch History of Road Paving. W. J. E. C. (Interesting facts relating to ancient and modern roads). Ill Car and Build—Oct. 9. 2500 w.

*9007. Advantage of an Asphalt Testing Laboratory. N. P. Lewis (Outline of work done in a small laboratory in Brooklyn). Munic Engng—Nov. 3000 w.

*9008. Specification Requirements for Asphalt, Asphalt Mixtures and Tests. A. W. Dow (Definitions of terms used in specifications, and an attempt to advance towards a standard specification for an asphalt mixture). Munic Engng—Nov. 5400 w.

*9009. Repairs of Asphalt Pavements. E. B. Guthrie (Classification and general discussion of asphalt pavement repairs). Munic Engng—Nov. 2200 w.

*9011. Testing Paving Brick. A. D. Thompson (Character of bricks suitable for paving, the necessity of testing to make sure of quality, and the essentials for satisfactory testing). Munic Engng—Nov. 3600 w.

*9012. Paving Streets with Brick. S. J. Hathaway (Account of brick paving as practiced in Marietta, O.). Munic Engng—Nov. 1900 w.

WATER SUPPLY.

8716. The New Croton Dam (Illustrated description). Sci Am—Oct. 17. 900 w.

*8756. Water Supply and Sewerage as Affected by the Lower Vegetable Organisms. Clarence O. Arey (A study of bacterial life in relation to sewerage, water supply and filtration). Jour Assn of Eng Soc—Sept. 3400 w.

*8859. Leicester Water Works (Illustrated detailed description). Eng, Lond—Oct. 9. 2300 w.

8883. Syracuse and Its Water Supply (Ilustrated description). Fire & Water—Oct. 24. 2000 w.

*8916. Contamination of Our Municipal Water Supplies. Frank J. Thornbury (A popular exposition of what renders a water supply bad or good, and upon the rarity of really safe water supply). Chau—Nov. 2500 w.

8934. The Water Supply System of Salt Lake City, Utah. W. P. Hardesty (Illustrated description). Eng News—Oct. 22. 4000 w.

*9004. Notes on Sinking, Timbering and Refilling Concrete and Puddle Trenches for Reservoir Embankments. William Watts (The paper gives an epitome of results of the author's experience in carrying out large reservoir undertakings). Eng, Lond—Oct. 23. 4300 w.

9020. The Manhan River Water Supply of Holyoke (Illustrated description). Eng Rec—Oct. 31. 1200 w.

†9042. A Practical Plan for Sand Filtration in Philadelphia. Allen Hazen (Deals with the possibilities of filtration, which are considered in relation to present sources of supply, sites for filters, system of distribution, reservoirs, consumption of water, nature of proposed filtration, population, magnitude of supply, cost estimates, with conclusions favorable to the practicability of the proposed system). Jour Fr Inst—Nov. 6500 w.

MISCELLANY.

8675. English Sewage and Water Works. W. M. Watson (Illustrated description of the ferozone and polarite system of sewage and water filtration). Can Eng—Oct. 1200 w.

*8704. Clean Streets and Their Benefits. La Salle A. Maynard (Advantages of clean streets, and a comparison of European and American systems of street cleaning). Am Mag of Civ—Oct. 1000 w.

*8763. Cost in Leeds of Destroying Refuse by Heat. Dr. Spottiswoode Cameron and Mr. George Darley (Tabulated data and explanatory description of experiments to determine cost). San Rec—Oct. 9. 800 w.

*9006. Meeting of American Society of Municipal Improvements (A critical review). Munic Engng. Nov. 1700 w.

We supply copies of these articles. See introductory.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Railway Extension in Bengal.

IT has been justly said that, where the railway penetrates, civilization immediately follows, and we may soon expect to see a marvellous transformation in some parts of British India. *The Indian and Eastern Engineer* outlines an important scheme of railway extension favored and urged upon the attention of the government of Bengal by the Bengal chamber of commerce. This question of railway extension has been before a committee of the chamber of commerce for a considerable period, and has been the subject of much careful consideration. Consultations by the committee with committees of associations connected with the chamber have been held, these associations representing industries whose continued success and development depend upon an energetic railway policy on the part of the government. The secretary of the Bengal chamber of commerce addressed to the government of Bengal a letter setting forth the requirements of the country as regards railway extension, the occasion of the letter having been a conference on railway schemes, held at Simla and presided over by the viceroy. The conference was participated in by members of the department of public works and finance, and specialists from other departments. The primary object of the conference was the consideration of schemes for feeder lines, and an effort to form a comprehensive idea of the requirements of the country in the matter of railway extension, and of the way in which such requirements could be met.

Without attempting to follow out in detail the schemes favored by the Bengal chamber of commerce, we will here speak of only one, which, if carried out, must inevitably affect materially the commerce of the civilized world. This project is for a railway line between Mogulserai and a point on the Bengal-Nagpur line near Purulia or Sini. Those who take sufficient interest in the subject to look up the geography of the country between the points named will see that, whether the projected road should connect these points by crossing the Sone near Dehri, or curve under Rhotas to Daltongunge and so on to the eastward, it can not fail to be an important addition to the railway facilities of the country, or to open up a commerce the value of which would be immense. By this line the whole of upper India could be supplied with coal mined one hundred and seventy miles from Mogulserai. The effect would be the development of new and needed industries in the whole of upper India, and especially a great iron industry.

In arguing for this line as opposed to a scheme for doing the same work by branches from the Grand Chord Line of the East Indian Railway, the committee of the Bengal chamber of commerce bases its protest on "the axiom in railway economies that whatever can be done by a direct line should not be done by branches; the reason being that the work done by branches must, of necessity, be partial, be severely localized, and be more expensive."

The projected line favored by the committee would skirt or pass through four great coal-fields, and nearly approach a fifth. The four fields which would be skirted or passed through are the Ramgarh and Bokaro field, the Karanpura and Baragaon field, the Auranga field, and the Daltongunge field. The Hutar field lying a little to the southwest of Palamow could be reached by a short branch from the main line.

Thus would be strung together five great coal-fields, while all along the line are deposits of iron ore of a superior quality. Tests show that some of this ore will yield from thirty-five to sixty per cent. of metal. Some magnetic ore yielding seventy per cent. of metal has been found. Limestone is abundant along the route, so that all the requirements for cheap and

abundant production of iron are grouped in an unusual degree. It is, therefore, believed that a great and attractive opening for capital exists in the region through which it is proposed to run this line.

No intelligent person can fail to perceive the possibilities this enterprise would open up. To us it seems that the long-slumbering orient is at last awakening to take its place in the grand march of civilization. Japan has led the van in this progress, but it does not seem either impossible or improbable that China and other oriental nations will ere long be found in step with the mighty tread of an advance that can be neither evaded or resisted.

By the carrying out of the railway scheme we have outlined, 1,100 square miles of coal-fields, estimated as capable of producing 12,000,000,000 tons of coal, will be opened up. Other important extensions are urged upon the attention of the government, and it is evident that the mercantile interests of Bengal are keenly alive to the commercial possibilities existing within the bounds of that great dependency.

Compressed-Air Surface Cars in New York.

OF the experiment with compressed-air motors on the Fort Lee branch of the Third avenue cable railway in New York city, the *American Machinist* (Oct. 22) says that its success has been complete. The two compressed-air motor cars placed upon the line August 3 have run since that date so monotonously well that there is nothing else to be said of their operation. The length of the round trip is four and three-eighths miles. These cars, running regularly, like the cable cars on the same line, says our contemporary, "have not only run without accident, but without incident. The greatest thing of all that can be said about them is that there is nothing to say." Our contemporary is an enthusiastic believer in the possibilities of compressed air as a transmitter of power, and, for the past year or so, has paid much attention to the increasing applications of compressed air in the various industries. Should its enthusiasm be suspected of coloring any statement made by it with reference to the Hardie motor cars on the road named, this suspicion will, upon investigation, prove entirely unfounded. The facts of the trial of these cars are exactly as stated, and they form a unique chapter in the history of compressed-air motors for railway purposes.

In the first place a person riding on one of these cars would detect very little, if any, difference in the speed, motion, or comfort of the vehicle as compared with a cable or a trolley car. If he noticed any difference at all, it would be in favor of the air-motor car, and would lie in the absence of jerks in starting and stopping. In the latter respect the cars are a marked improvement over cars hither employed.

For some reasons not made public the cost of running these cars is, as yet, withheld from publication, although a careful record has been kept. It is, however, given out that the experiment indicates a highly satisfactory economy. Probably commercial reasons exist for not stating the exact figures. Be this as it may, there seems good reason to believe that the system of propelling cars by compressed air has been shown to be completely practicable, both from an engineering and a commercial point of view.

If this prove true, there are those now living who will remember earlier attempts to do the same thing, the difficulties then encountered, and the failures. These witnesses of the former experiments will, as a rule, attribute the present success very much to increased engineering and mechanical resources, but still more to the dogged obstinacy and persistence with which some of the best engineering talent has insisted on an affirmative answer to the question of the practicability of compressed-air motors for street-car propulsion.

Advances in Street-Railway-Car Building.

THE progress that has been made in street-railway-car building forms the subject of an illustrated article occupying eight pages of the *Street Railway Journal* for October. From this article one gains

a good idea of the care and thought which have been bestowed upon the equipment of street railways. We are informed thereby that "in no one department of street-railway operation have more changes been made during the past five years than in the style of cars used." The tendency during this period has been toward more substantial construction. At the same time more attention has been paid to decoration. The experience of the past has taught the lesson that the best "economy lies in the direction of carefully and strongly built cars." Especially has this lesson been enforced by experience in electric-railway service.

Two modes of construction have prevailed. One class of builders have based construction upon precedents and data derived from steam-railway cars. Another class has adhered to the model of the old sixteen-foot horse-car, under the belief that transverse strains in street cars preponderate over longitudinal strains. and, as the old-style horse-car was modeled after the street omnibus, or stage coach, the cars of the latter class of builders show a marked resemblance to those now nearly extinct vehicles. Both classes of makers are, however, studying to reach a substantial construction, in which effort iron and steel have been freely substituted for wood.

Not only has decoration of the interiors of street cars been carried to an extent very much beyond that of the street cars of only a few years ago, but the seats are more luxuriously upholstered. With the electrically-propelled cars electric lighting of cars has also come, and in this respect the modern street car is immeasurably in advance of the horse-car now passing into ancient history.

The introduction of mail, express, and parlor cars on the street railways, particularly on the suburban railways, has proved a welcome innovation. The introduction of the beautifully-finished and gorgeously-lighted special cars for pleasure parties has demonstrated that it will pay most of the roads in large cities to cultivate this class of traffic.

Street-railway cars are also made more spacious and commodious than they have ever been at any previous period. The trolley system will handle cars very much too heavy for horse propulsion. This makes entirely practicable cars capable of holding a much larger number of passengers than could once be carried in street cars, and the earning capacity of a street-car line of any given length with a given number of employees has been very much increased by this change.

Many other interesting particulars are given in the article thus briefly reviewed. In looking it over those not entirely familiar with street-car building will feel some surprise at the variety of designs exhibited in the illustrations, wherein the work of a considerable number of prominent car builders is represented.

High Speed on Curves.

MR. JOHN RIEKIE, writing from Sukkur, India, to *The Engineer* (London), expresses views regarding the safety of fast running around railroad curves which will be surprising, at least to the "travelling public," in whose interest especially he writes.

His letter is called forth by a leader on the Preston accident, appearing in *The Engineer*, and containing the sentence; "The only other cause available was running around the curve at too high a speed."

Mr. Riekie says: "Now, I deny that high speed round a curve will cause a derailment. I am treating the word derailment as referring to the flange of the leading wheel mounting the outer rail. The result of an accident, when going at high speed, is most disastrous, but it is in my opinion most regrettable that the travelling public should be taught that it tends to derailment, when it is the reverse in actual practice. A little further on in your article you show that the load may be fifty per cent. more on the outer wheels than on the inner ones, and that the extra loading to the outside promotes safety. How, then, can high speed cause derailment? During my wide experience of nearly thirty years I have never known a single derailment having occurred owing to speed; the reverse is the case, and I have known for

an actual fact that drivers have had to get up a speed of twenty miles to prevent a derailment when it was impracticable to go round a curve at five miles an hour without derailing.

"I should like to quote cases that might help to show that high speed does not tend to derailment. First, in 1879, when the extension of the Punjab Northern State Railway was being made beyond Jhelum, Mr. Avern, the engineer-in-chief of the extension, consulted me as to the extraordinary behavior of an engine that was lent to him for ballasting purposes. The tender of this engine got derailed almost daily when an official was on the train, not so when the driver was by himself. There was a restriction of speed on this curve; I explained what occurred at high speed, and that it was quite possible that the driver, when alone, got up a fairly high speed before going round the curve.

"Second, on a certain section of the North-Western Railway a part of the line on the 1 in 25 grades had been laid with curves having 819 feet radius, the superelevation of which had by an error been made ¾ inch in place of 3 inches. When this part of the line was inspected by the officials, the error was noticed, and a remark was made that it would be impracticable for a runaway wagon to go down the grade without derailing. I ventured the suggestion that it might capsize, and that the want of cant would enhance the safety of the vehicle from derailing. This was considered preposterous, and I got permission to try the experiment. Needless to say, when the experiment was made, the vehicle ran round with perfect safety. The speed attained was about fifty-five miles an hour. I do not know what percentage of weight was on the outer wheels when on the curve,—probably ninety per cent.; but surely it stands to reason that, if the weights on the outer wheels increase with the speed, it is utter nonsense to expect the flange to be able to climb. Here, then, are two practical facts—I have known very many similar—to prove that high speed will not tend to derailment."

It seems as if, from such a store of facts, Mr. Riekie might have selected stronger confirmations of his argument; for one of his instances is susceptible of various explanations, and the other is purely negative. On the other hand, any observer of railroad accidents can recall numerous cases in which vehicles were derailed on attempting to pass, at unusually high speed, over curves which they travelled with ease and safety at low speeds.

With all respect to Mr. Riekie's experience, it seems likely that he has appreciated one of those half-truths which are so dangerous. The increase of centrifugal tendency with increased speed does, of course, tend to throw additional weight on the outer rail, and, to that extent, to oppose the tendency of the wheels to mount on that side.

But the superimposition of weight is only an indirect or resultant effect; the other and more important component into which the centrifugal force is resolved is an outward pressure of the wheel-flange on the rail-head. Given the factors of speed, weight, curvature, and wheel and rail section, it should be no difficult matter to determine the point at which the outward moment would overcome the extra load on the outer rail, and a "derailment," in Mr. Riekie's strict and limited sense, would occur.

In practice, of course, some defect of equipment or track surface, or sudden inequality of pull, might bring the catastrophe before the theoretical limit was reached.

But there is another possibility which Mr. Riekie's technical definition would ignore, and that is that the track may fail, under the lateral pressure, before the point is reached at which the wheels climb the rail. To the passenger who experiences the consequences, the question whether a broken or spread rail is properly "a derailment" will have little importance, and even the coroner's jury will hardly go into the niceties of the distinction. Something also might be said with reference to wear of flanges as tending to derailment when the centrifugal force is pressing the flange strongly against the curved surface of the rail.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

CONSTRUCTION.

8726. The Proposed Chesapeake and Ohio Improvements at Richmond (Photographs, map and partial details, with description of an important piece of track elevation and increase of traffic facilities). R R Gaz—Oct. 9. 4000 w.

8826. Electric Roads Near Cleveland (Brief historical review, with map and notes of current work). R R Gaz—Oct. 16. 900 w.

*8860. The Lanarkshire and Dumbartonshire Railway (Map and brief description of the line, bridges, &c.). Eng, Lond—Oct. 9. 800 w.

†8961. Steel Sleepers in Queensland. John Alfred Griffiths (Describes the construction of the Normanton-Croydon Railway, 94 miles in length). Ind and East Eng—Sept. 19. Serial. 1st part. 2300 w.

†8962. Railway Extension in Bengal (Extract from a letter addressed by the Secretary of the Bengal Chamber of Commerce to the Government of Bengal. Information regarding proposed roads). Ind and East Eng—Sept. 19. 2400 w.

8987. The Siberian Railroad (Some of the more important particulars of this great enterprise). R R Gaz—Oct. 23. 2000 w.

9055. Double Tracking on the Chicago & Northwestern Ry (Construction of another track, between Baraboo and Madison, with improvement in grades and straightening of alignment. Ilustrated by diagrams). Ry Rev—Oct. 31. 1600 w.

9056. Longitudinal Sleepers in Austria (From an interesting paper presented by W. Hohenegger before the International Ry Congress. Illustrated account of construction). Ry Rev—Oct. 31. 1000 w.

*9120. Glasgow Central Railway (Illustrated description of the portion of the road from Glasgow Cross to Dowsholm and Maryhill). Eng Lond—Oct. 30. 2200 w.

ELECTRIC AND STREET RAILWAYS.

*8781. Test of Railway Insulators. L. A. Murray (A report of a test of glass and porcelain railway insulators made in the Electrical Engineering laboratory of Cornell University). Slb Jour of Engng—Oct. 1400 w.

8802. Compressed Air Surface Cars in New York (Present status of this system of car propulsion). Am Mach—Oct. 22. 1400 w.

†8805. The City of St. Louis and Its Transportation System (A full discussion of the St. Louis street railways with respect to relation to distribution of population, finance, equipment, power, track, &c., with illustrations, diagrams and tables). St Ry Jour—Oct. 20000 w.

†8806. The Great Street Railway Properties of America (A tabulation of mileage, capitalization, liabilities, receipts and charges of twenty-nine important systems, with descriptive comment). St Ry Jour—Oct. 7000 w.

†8808. The New York State Street Railway Association (Brief report of annual meeting, with papers and reports presented). St Ry Jour—Oct. 12400 w.

*8809. Trolley Express Service in Brooklyn (A brief description of the system and development of the business). St Ry Rev—Oct 15. 600 w.

*8810. Trolley in Egypt. (An account of the inauguration of the system in Cairo). St Ry Rev—Oct. 15. 600 w.

*8811. Electric Car Brake Adopted by Chicago City Railway (Description and illustration of the device). St Ry Rev—Oct. 15. 700 w.

*8812. Street Railways of St. Louis (A review of the system and of characteristic and important features). St Ry Rev—Oct 15. 8800 w.

*8813. A Few Notes on Early Electric Railway Work in Pittsburg. Leo Daft (Illustrated reminiscences). St Ry Rev—Oct. 15. 3500 w.

*8814. Progress on the Boston Subway (Account of progress and of peculiar features in the work, with map and illustrations). St Ry Rev—Oct. 15. 400 w.

*8817. Cable Traction in the Isle of Man (Illustrated description of the installation, equipment and operation of the Upper Douglas Tramway, with many details). Ry Wld—Oct. 2400 w.

*8820. Tramway Permanent Way, as Adaptable for Mechanical Traction. John S. MacGregor (A detailed consideration of the construction of what may be deemed at the present time a thoroughly good permanent way). Ry Wld—Oct. 4000 w.

*8824. Liverpool Overhead Railway. S. B. Cottrell (Abstract of a paper read before the British Assn. Detailed description of the line, which is partly elevated and partly underground, and operated throughout by electricity). Elect'n—Oct. 9. 4400 w.

8825. How Electric Railroad Eqipment May Be Simplified (Shows the irregular apportionment of recent improvements in design, and explains and illustrates the proposed simplification in arrangement of apparatus). R R Gaz—Oct. 16. 2800 w.

8841. An Experiment with an Improvised Booster on Street Railway Feeders. Robert P. Brown (Account of the reasons leading to the adoption of the system, and description of the plant as installed,

with map, plan and load curves). Elec Wld—Oct. 24. 1800 w.

8842. The Electric Underground Road in Budapest. Josef Herzog (A descriptive account of the inception of the project, the construction of the road and installation of power. Illustrated). Elec Wld—Oct. 24. 1300 w.

8843. Electric Railway Construction. Albert Vickers (A review of modern standards, chiefly of track. Illustrated). Elec Wld—Oct. 24. 2000 w.

8845. Note on the Pressure of the Trolley Wheel Against the Wire. Herman S. Hering (A discussion of the effect on sparking, with argument in favor of high pressure, with notes of tests and the results). Elec Wld—Oct. 24. 1400 w.

8846. Some Prominent Features in Electric Railway Construction (Points of special engineering difficulty of interest in construction on roads near New York City). Elec Wld—Oct. 24. 1200 w.

8847. A New Method of Detecting Waste of Power in Electric Railways Harold P. Brown (Description of the method and exposition of the importance of the results in economic regulation of the power-station). Elec Wld—Oct. 24. 1600 w.

8849. The Evolution of the Street Railway Motor. Charles T. Child (Historical review, with description and illustrations of successive types). Am Elect'n—Oct. 3500 w.

8850. Steam Engines for Electric Railway Service (Discussion, with illustrations of various types). Am Elect'n—Oct. 4000 w.

8862. The Fairmount Park Transportation Co., of Philadelphia, Its Plans and Work (Illustrated descriptive account). Elec Eng—Oct. 21. 1500 w.

8863. St. Louis Electric Railway Power Stations (Plans and descriptive accounts of several power stations). Elec Eng—Oct. 21. 1500 w.

8872. Street Railway Easement Curves. Charles A. Alden (Illustrates the racking effect of curves on long cars with short wheel-base, and argues the importance of applying the spiral to street railway curves). Eng News—Oct. 15. 600 w.

8873. The Rowan Steam Street Car Motors in France (Descriptive account of the equipment and operation). Eng News—Oct. 15. 600 w.

8875. The Street Railway Track of the Future (A discussion of present problems and practice, and of essentials of the ideal). Eng News—Oct. 15. 1800 w.

8935. Momentum Friction Brake for Electric Cars (Illustrated description of a recent invention by W. G. Price, of Chicago, which has had six months successful operation in actual service). Eng News—Oct. 22. 350 w.

8939. The Third Rail Electric System of the New York, New Haven and Hartford R. R. (Illustrated description). Eng News.—Oct. 22. 600 w.

*8951. Electric Traction. R. H. Smith (The reasons why electric transmission for railway purposes has been delayed in England, the importance of electrical engineers acquainting themselves with the experience gained in America. Frequent reference is made to information from the Street Railway Journal). Eng Lond—Oct. 16. 4000 w.

8956. President Littell on the Street Railway Situation (Abstract of address delivered at St. Louis).

8957. Storage Batteries in Use by the Union Traction Co., Philadelphia (Brief illustrated account of the installation just completed for the Union Traction Co). Elec Eng—Oct. 28. 500 w.

8958. The Modern Power House. Richard McCulloch (Paper read before the Am. St. Ry. Assn., St. Louis. The first part discusses location, building and steam generating apparatus). Elec Eng—Oct. 28. Serial, 1st part.3700 w.

8959. Track and Track Joints, Construction, Maintenance and Bonding. M. K. Bowen (A discussion of the subjects mentioned in title. Read before the Am. St. Ry. Assn., St. Louis). Elec Eng—Oct. 28. 2800 w.

8960. How Can the Revenue of Street Railways Be Increased? C. Densmore Wyman (Read before the Am. St. Ry. Assn. Offers suggestions, advises advertising, making service attractive, discusses the transfer system). Elec Eng—Oct. 28. 3800 w.

8971. Modern Overhead Construction for Electric Railways. Benjamin Willard (Abstract of a paper read at the annual convention of Am. St. Ry. Assn. Discusses methods of construction and gives the writer's preferences and reasons). Eng News—Oct. 29. 3000 w.

8972. Spiral Curves for Street Railways. Charles A. Alden (Tables designed to meet most cases arising in usual practice, with explanations and remarks). Eng News—Oct. 29. 2400 w.

*9010. Modern Street Railway Track Construction on Asphalt Paved Streets. F. W. Cappelen (Description of work in Minneapolis. The street railway company aim to construct a first-class track in every respect). Munic Engng—Nov. 2200 w.

†9068. Construction and Maintenance of Electric Railway Tracks. George H. Neilson (Abstract of paper read before the Penna. State Assn. Treats briefly of foundation, concrete, ties, rails, splices, frogs, &c., and of points of interest in the construction of suburban roads). St. Ry Jour—Nov. 2000 w.

†9069. Street Railway Trucks. John N. Akarman (The object of the paper is to give hints to street railroad men which will enable them to decide what type of

truck is best adapted to the purpose. Read at the St. Louis Convention). St Ry Jour —Nov. 3000 w.

†9070. The Selection and Management of Employees. W. F. Kelly (Suggestions offered from large experience, observation and inspection. Read at St. Louis Convention). St Ry Jour—Nov. 3000 w.

9077. How to Increase the Working Efficiency of Railway Motors. William Baxter, Jr. (A review of the progress, statement of principles, and account of the operation of motors of the writer's own design, in which the principles referred to were adopted). Elec Wld—Nov. 7. 2500 w.

9087. Cable Car Brakes. Paul Synnestvedt (A letter to the editor criticising the form of brake commonly used). Ry Mas Mech—Nov. 1100 w.

*9117. The Bristol Electric Tramway (Illustrated description of important changes and developments). Engng—Oct. 30. 2000 w.

*9138. A Review of Electric Traction (Extended extract of a voluminous paper by M. E. de Marchena, with comments). Elect'n—Oct. 30. Serial, 1st part. 4000 w.

*9139. The Effect of Insulation Resistance and Capacity on the Absolute Potentials in Alternate Current Systems. A. Von Ettinghausen and G. Ossana (From the Zeitschrift fur Elektrotechnik. The paper is chiefly devoted to the consideration of three-phase circuits, but the methods are also applicable to single and two-phase alternating systems). Elect'n—Oct. 30. 2400 w.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

8724. Official Report of the 27th Annual Convention of Master Car and Locomotive Painters' Association (Full report of officials, committees, &c., and discussions. The topics include compressed air for burning off cars, flatting of varnishes, painting locomotive jackets and galvanized iron, the enamel process, locomotive painting, spontaneous combustion in paint shop, painting super-heated parts, &c.). RR Car Jour—Oct. 60000 w.

8725. A New Baldwin Locomotive for the Lehigh Valley Railroad (Sectional drawings and details of new wide-firebox engine for Lehigh Valley RR.). RR Gaz—Oct. 9. 500 w.

8727. A 100-Per Cent. Rail Joint. M. W. Thomson (Brief discussion of the theory of the joint and splice, and illustrated description of an improved device). RR Gaz—Oct. 9. 500 w.

8733. Cast Iron vs. Steel Tired Wheels. R. P. C. Sanderson (From a paper read before the Southern & Southwestern Railway Club. A comparison of merits, defects and economy, with argument for the chilled wheel. Also editorial). Ry Rev—Oct. 10. 10500 w.

*8819. An Anglo-American Express Engine (Illustrated description and details of an English built express locomotive approaching closely the American type). Ry Wld—Oct. 500 w.

8844. The Heilmann Locomotive. H. Ward Leonard (An illustrated description of the type, with some dimensions and performance figures). Elec Wld—Oct. 24. 1700 w.

*8848. The London Engineer's View of the Locomotive Question (A review of the question of heating surfaces, with general tone unfavorable to the efficiency of the American type). Engng Mech—Oct. 900 w.

*8942. Carriages for Local Passenger Traffic; Dutch Central Railway (Illustrated description of carriages used by the Dutch Central Railway Company at Utrecht). Engng—Oct. 16. 400 w.

*8967. New Equipment on the Baltimore & Ohio Railroad (Dimensions, with photographs, of several classes of engines for road named). Am Eng & R R Jour —Nov. 2000 w.

†8976. Car Roof Construction (Committee reports describing various styles of construction, with their characteristics and defects). Cent Ry Club—Sept. 1300 w.

†8977. Painted and Planished Locomotive Boiler Jackets (Committee report comparing first cost and maintenance expense. The figures and comment are generally favorable to painted jackets, but no conclusions are presented). Cent Ry Club—Sept. 500 w.

†8978. Car Repairs Under the New Rules of Interchange (A discussion of the interpretation of the rules and of repair problems arising thereunder). Cent Ry Club—Sept. 13000 w.

†8979. The Effect of High Rates of Combustion Upon the Efficiency of Locomotive Boilers. W. F. M. Goss (Full text of the original paper, showing decreased economy with increased rates of combustion, with charts, diagrams, description of apparatus and methods used in testing and the entire discussion). N Y RR Club —Sept. 17. 12500 w.

8982. A Water Tube Locomotive Boiler (An illustration from the C., M. & St. P. Ry. General description of construction with sectional drawings). Ry Rev—Oct. 17. 900 w.

8983. Arrangement of Wood-Working Machinery in Railroad Shops (An example of advantageous arrangement, taken from the C., M. & St. P. shops at Milwaukee, with plan). Ry Rev—Oct. 17. 900 w.

8985. A Locomotive Shop Travelling Crane, 5,000 pounds capacity (Description with drawings). Ry Rev—Oct. 17. 500 w.

8986. Some Examples of Metal Under-Frames from Foreign Countries (Illustrated descriptions of a number of designs used in European practice). R R Gaz—Oct. 23. 1800 w.

8996. Two New Trucks for Freight Cars and Tenders (Designs for metallic construction brought out by the Buckeye Engine Co., of Salem, O. Illustrations). Ry Rev—Oct. 24. 700 w.

*9001. Express Compound Locomotive, Imperial-Royal Austrian State Railways (Illustrated description of the most advanced type of express locomotive in Austria). Eng, Lond—Oct. 23. Serial, 1st part. 800 w.

*9003. Locomotive for London Expedition Railway (Detailed description with engraving and specification.) Eng, Lond—Oct. 23. 1200 w.

9054. Interesting Locomotives from the Baldwin Locomotive Works (Engravings and dimensions). Ry Rev—Oct. 31. 700 w.

*9061. Heavy Consolidation Engines for the Baltimore and Ohio Railroad (Illustration and general dimensions). Loc Engng—Nov. 300 w.

*9062. Mogul for the Great Northern Railway (Illustrated description). Loc Engng—Nov. 400 w.

*9063. Some New Ten-Wheelers for the Baltimore and Ohio (Illustration and general dimensions). Loc Engng—Nov. 500 w.

9098. Some of the Questions of Large Cars. E. W. Judd (Opinions from various sources, giving views of representative men in different departments of the service, showing the importance of the problem. Ind). RR Gaz—Nov. 6. Serial, 1st part. 3200 w.

9141. Preservation of Metal Frames for Tenders and Cars. E. M. Herr (Abstract of a discussion before the Western Railway Club, with diagram showing corrosion). Ry Rev—Nov. 7. 1100 w.

9142. New Eight-Wheel Locomotive—Chicago, Rock Island & Pacific Ry (Dimensions, with sections and description). Ry Rev—Nov. 7. 900 w.

9143. Automatic Lubricators for Locomotives (Abstract of paper by Mr. Parker, recently read before the Northwest Ry. Club, with editorial account of experiments on the St. Paul and Duluth RR.). Ry Rev—Nov. 7. 2700 w.

MAINTENANCE OF WAY AND STRUCTURE.

8874. Standard Track and Three-Rail Switch Work; Denver and Rio Grande R. R. (Description, with diagrams). Eng News—Oct. 15. 400 w.

9097. Track Elevation in Chicago (Illustrated description of the raising of the joint tracks of the Lake Shore and Michigan Southern and the Chicago, Rock Island and Pacific Railways). R R Gaz—Nov. 6. 2500 w.

SIGNALLING.

8729. Signal Rules for Trains Approaching Crossings (A comparison of English and American practice, with exposition and discussion, especially of the English system). RR Gaz—Oct. 9. 2200 w.

8940. A Double Blade Semaphore for Block Signalling on the Park Avenue Viaduct, N. Y. Central RR. (Description of special form of signal designed for special work). Eng News—Oct. 22. 1200 w.

TERMINALS AND YARDS.

8995. Railroad Terminal Stations. E. K. Turner (Read before the New England RR. Superintendents. The paper is confined to the consideration of stations for passenger traffic). Ry Age—Oct. 23. 4000 w.

TRANSPORTATION.

8731. Inter-Line Railway Tickets (Action of the General Passenger Agents' Association to secure protection against fraud and misuse). Ry Age—Oct. 9. 2800 w.

8735. Abolish the Ton-Mile (Editorial argument opposing the ton-mile, except as a basis of comparison, and granting it but limited value even then). Ry Rev—Oct. 10. 900 w.

*8950. Mineral Traffic on British Railways (Gives an idea of the extent and distribution of mineral products, their value, &c. Facts taken from report and mining statistics of the United Kingdom). Trans—Oct. 16. 1200 w.

8980. Train Dispatching by Telephone (Editorial treating the operator's strike on the C. P. R. R. as the possible originating cause of an extended movement toward train dispatching by telephone). Ry Age—Oct. 16. 1000 w.

8984. Rate Wars and Rate Control (Editorial argument for divorce of rate-making power from traffic management). Ry Rev—Oct. 17. 800 w.

*9026. Transport Problems in South Africa (Discusses the questions of ocean transport, railway communication, &c.). Trans—Oct. 23. 2200 w.

MISCELLANY.

8728. The Railroads of the United States in 1895 (Editorial abstract of the Interstate Commerce Commission statistics, with running comment). RR Gaz—Oct. 9. 1800 w.

8730. British Railroad Statistics in 1895 (Abstract of Board of Trade returns). RR Gaz—Oct. 9. 700 w.

8732. A Diagram for Hauling and Tractive Power of Locomotives (Designed to compare the power of locomotives having different sized cylinders and driving wheels, and to ascertain the effect of changing the dimensions. The construction of the diagram is explained and the formulae used are given). Ry Rev—Oct. 10. 600 w.

8734. A Unique Bituminous Coal Storage Plant (Illustrated description). Ry Rev—Oct 10. 1000 w.

*8815. A Thousand Millions in British Railways (A review and analysis of the Board of Trade report, especially as to capital additions and the traffic receipts for 1895). Trans—Oct. 9. 2200 w.

*8816. Railway Accidents and the Lessons They Teach (Analytical discussion of the Government report with notes of the progress in introducing safety appliances and also of hours of labor and wages). Trans—Oct. 9. 2500 w.

*8818. Railways of the United Kingdom (Analytical comparison of British railway returns, of construction, traffic and revenue, with charts). Ry Wld—Oct. 1000 w.

8821. Apprentice System—Union Pacific Railway (Regulations, form of application and illustrations of examinations). Ry Mas Mech—Oct. 2500 w.

8828. Fuel Loss Due to Forcing Locomotives (Editorial review of Prof. Goss's paper read before the N. Y. Railway Club in Sept., with diagrams). RR Gaz—Oct. 16. 1400 w.

†8836. Railways of Belgium (Historical review, table of mileage and balance sheet of receipts and disbursements). Cons Rept—Oct. 1800 w.

*8853. The Longest Non-Stopping Railway Run in the World. Charles Rous-Marten (Detailed account of the daily run of 194 miles from Paddington to Exeter on the Great Western Railway). Eng, Lond—Oct. 9. 1700 w.

8864. Contact Shoe and Brake on the New York, New Haven and Hartford Railroad (Illustration and description of the shoe and air compresser apparatus and its action). Elec Eng—Oct. 21. 600 w.

8927. The Battle of the Snow Plows. Cy Warman (Illustrated description of a snow plow contest in the Rocky Mountains, with a brief account of pilot plows and snow bucking). McClure's Mag—Nov. 2000 w.

*8931. Problems of Railway Management. Henry Clews (The causes for diminution in value of railway investments, the evils from interference of legislation, &c.). Gunton's Mag—Nov. 2400 w.

*8945. British Railway Finance (The benefit to English railway interests due to distrust of foreign securities is discussed, and the results of investing the capital in British railways are declared satisfac- Engng—Oct. 16. 700 w.

*8946. The Fatal Derailment at Preston (Statement of conditions and facts relating to the accident, with diagram of curves). Engng—Oct. 16. 700 w.

*8953. The Preston Accident (Editorial comment on Col. Yorke's report, with statement of the accident and the lesson it teaches). Eng, Lond—Oct. 16. 1700 w.

*8968. Car Heating by Steam. R. M. Dixon (The success of steam heating, description of method, rules for handling steam-heating equipment, &c.). Am Eng & R R Jour—Nov. 1200 w.

*8969. Cast-Iron vs. Steel-Tired Wheels. R. P. C. Sanderson (From a paper before the Southern and Southwestern R. R. Club. The questions of safety, weight, running qualities and rail wear are briefly considered, and also the cost). Am Eng & R R Jour—Nov. 1100 w.

8981. Narrow-Gauge Railways (A tabulation of the narrow-gauge roads of the United States, Canada and Mexico, with comment on present status of construction). Ry Age—Oct. 16. 500 w.

8989. The New Russian Locomotive Works (Photographs and description of some of the tools for the Sormovo Co. about to engage in locomotive building at Nijni Novgorod, Russia). Mach—Nov. 600 w.

*8999. Railway Speeds (Arguments emphasized and illustrated by the Preston accident, relative to the consideration traffic managers should show to the locomotive department.) Eng, Lond—Oct. 23. 2000 w.

9031. Train Accidents in the United States in September (Classified table, with editorial comment). R R Gaz—Oct. 30. 2800 w.

9057. Railway Accidents of a Year in England (Editorial comment on the report made by Francis J. S. Hopwood to the British Board of Trade). Ry Rev—Oct. 31. 900 w.

†9058. Air Cutter to Reduce Atmospheric Resistance to Railway Trains. H. W. Perry (Graphical representations of air resistance are given and remedies suggested). Ind Engng—Sept. 26. 1000 w.

*9065. From the Imperial Railway of China (Letter from C. W. Kinder, chief engineer of the Imperial Chinese Railway at Tientsin, China. Also specifications for passenger and freight engines as sent out by the locomotive superintendent for bids). Loc. Engng—Nov. 2000 w.

*9066. The Way They Take Care of Queen Victoria When She Takes a Railroad Ride. James Thompson (Interesting account of the extreme caution exercised). Loc Engng—Nov. 1200 w.

*9067. Government Railroad Track Experiments (Report of the commanding officer at the Watertown Arsenal, Mass., regarding railroad-track experiments). Loc Engng—Nov. 1200 w.

9086. Snow Plow, Grand Trunk Railway (Illustrated description of a plow made in the shops of the company, which successfully clears the tracks). Ry Mas Mech—Nov. 1000 w.

*9119. Road and Railway Communication in Bosnia and Herzegovina (Treats briefly of the excellence attained in the last twenty years in internal traffic communications). Eng, Lond—Oct. 30. 2000 w.

SCIENTIFIC MISCELLANY

Explosions of Acetylene.

NOTWITHSTANDING the assertions of interested parties that acetylene can be handled and stored without such risk as ought to obstruct its use as an illuminant, it is a matter of fact that there have been a number of explosions of acetylene. The circumstances under which these have occurred are not all of a nature to reassure doubters. *The Examiner* (Oct. 23) editorially reviews the list of explosions that have attended the recently-increased use of acetylene. It says that "the scientists . . . who have been giving a good deal of attention to acetylene" have "approved of its use, if sufficient care were taken in its employment; and, with a view to securing perfect safety, a series of rules and regulations has lately been put in force."

It was, therefore, supposed that, if these rules were observed, all danger would be removed.

"Users have had their confidence severely shaken during the past few weeks by two explosions that have been attended with fatal results. First, an apparatus employed in a café at Lyons exploded, completely wrecking the premises, and killing two persons and injuring several others. Last week yet another accident took place, when a steel receptacle containing liquid acetylene exploded at the works of M. Raoul Pictet, Rue Championnet, Paris. A part of the works was blown down, two workmen were killed, and another injured, and not a pane of glass was left in the windows of the large block of buildings. The effect of the explosion was very much like that of dynamite. The unfortunate workmen were torn to pieces, and parts of their bodies were scattered about the yard. The flesh was blackened by a substance which had penetrated into the skin, and this has enabled the experts to formulate a plausible theory as to the cause of the explosion."

Now, Raoul Pictet is famous the world over for his skill in handling, compressing, and liquefying gases. He is also a highly-trained scientist, inventor, and mechanican. When a man of this kind cannot manage acetylene without wrecking his property, it is little wonder that laymen should be timid.

At Lyons the explosion was caused by gaseous acetylene. In the Pictet works a steel receptacle of great strength, containing acetylene produced under a heavy constant pressure, burst, with the result above stated.

Contrary to the opinions of the greater number of experts, M. Pictet favors the distribution of acetylene in the liquid state, rather than the local manufacture of the gas from calcium carbid in an apparatus. "He argues that the danger arises solely from the impurities contained in the acetylene, and that these impurities must be removed by special processes before the acetylene can be liquefied without leaving a residue. He contends that another enormous advantage lies in the convenient and portable form of the acetylene receptacles, which may be conveyed any distance ready for use, and will, in course of time, be purchased at any store as required. There is, he asserts, less danger to be feared from liquid acetylene than from liquid carbonic acid, for this latter will only liquefy under pressure of sixty-five or seventy atmospheres, while acetylene requires a pressure of not more than twelve atmospheres. Nevertheless, there are two miillion carbonic acid cylinders circulating on the railways, and yet accidents from this cause are very rare. The experiments that have been made by MM. Barthelot and Vieille, the chief engineer of the French explosives department, would seem to bear out some of the arguments of Monsieur Pictet, but they still show that liquefied acetylene is more liable to explosion than the gas; and this has been repeatedly insisted upon by M. Berthelot, who has made several commun-

ications on the matter to the Académie des Sciences. They took two steel receptacles each of a capacity of about a liter, and filled one with gaseous acetylene under a pressure of ten atmospheres, and the other with liquefied acetylene with a density of .3,—that is to say, of 300 grams to the liter. The cylinders were dropped, first of all, from a height of six meters on to a steel anvil, and no explosion ensued. They were then broken by a hammer of 280 kilograms in weight, falling six meters. The compressed gaseous acetylene did not explode, but in the other cylinder an explosion took place after an almost imperceptible interval. This, it is supposed, resulted not from the pure acetylene, but from the mixture of the explosive impurities in the acetylene with the air the moment they were freed from the cylinder. The inflammation of this gas is believed to have resulted from the sparks flying from the pieces of the steel receptacle when it was broken. Then a wrought-iron bottle was taken, enclosing another containing gaseous acetylene compressed at ten atmospheres. It was fired at with a gun, and the ball penetrated the outer bottle and dented the inner one. No explosion followed the shock. A similar bottle was then filled with liquid acetylene, and a charge of 1.5 gram of fulminate of mercury was fired inside. The bottle exploded with great violence, and the effects were exactly the same as with other explosives. It therefore appears that acetylene in its liquid form is much more liable to explode than in its gaseous state, even under a pressure of ten atmospheres."

M. Pictet says that absolutely pure acetylene is obtained by his process. But either his process failed to produce pure acetylene, or his theory that pure acetylene is not explosive is not sustained. The material of which the cylinders are made is nickel steel, and they are tested to a pressure of about 3,750 pounds per square inch. The rupture of such a cylinder could be effected only by a mighty force, and its destructive power, when ruptured, would be tremendous. The fact remains, that carbonic acid requiring for its liquefaction five or six times as much pressure as acetylene is constantly handled on railways and in manufacturing establishments in large quantity, practically without serious accidents; and in precisely the same kind of cylinders as the one exploded at M. Pictet's works, and in which he proposes to distribute liquefied acetylene to consumers as a commercial illuminant. How can these apparently conflicting facts be reconciled?

It is supposed that the explosion was caused by one of the workmen in screwing in a plug, the heat thus generated igniting the liquid. The basis for this opinion is the presence of the black substance on the skin of the men injured, above alluded to. As this substance forms in quantity only upon a considerable quantity of acetylene, it is inferred that the receptacle was full, and, it being usual to insert the plug when the filling is complete, it is therefore inferred that the plugging was in progress when the explosion took place. Evidently this is a mere guess, and still more evidently there is something yet to learn about acetylene.

A New Ambulance Launch.

UNDER the direction and superintendence of Mr. Charles Thompson, a member of the Institute of Naval Architects, another steam launch for the ambulance service of the Metropolitan Asylums Board on the Thames river has been constructed. This boat, called the "Geneva Cross," will be the fourth employed in the service, the three previously built being the "Red Cross," "Maltese Cross," and "Albert Victor." From a description in *Industries and Iron* (Oct. 9) we gather the following particulars of the boat, and of the ambulance service in which it will be employed.

The peculiarities of the design are shallow draught, accommodation for recumbent patients and for visitors, a high rate of speed, and minimized vibration. The two latter features are said to have been well worked out, and much satisfaction with the boat has been expressed.

Some particulars of this marine ambulance service show its great importance. Of late years there has been an enormous

amount of ambulance work of late years which the Metropolitan Asylums Board has been compelled to grapple with and to deal with expeditiously, especially that portion relating to the removal by water of infected patients suffering from small-pox. During certain periods it is probably necessary to deal only with comparatively few cases of this dreadful disease, but frequently, and indeed suddenly, it assumes gigantic proportions in the form of a violent epidemic, when it is not uncommon to be obliged to remove forty or fifty cases in one day; in fact, as many as one hundred and four cases have been conveyed to the hospital ship in one day by the ambulance steamers. The work is, however, carried out quickly and unostentatiously day by day, and its extent is probably known only by few who reside in the vast area of the metropolis under the jurisdiction of the board. Seeing that the ambulance work of the board has now reached Tottenham, Penge, and goes as far as West Ham, it became imperative that a launch suitable for the conveyance of infected patients by water from the shallow reaches of the Upper Thames should be provided. There are also three wharves, the property of the board, from which infected patients are embarked and disembarked after being cured at the hospital ships,—*viz.*, the West Wharf, at Fulham; the North Wharf, at Blackwall; and the South Wharf, at Rotherhithe, where isolation shelters are also provided for the reception, examination, and accommodation of doubtful cases of smallpox. Such patients are detained in these shelters until the disease from which they are suffering is sufficiently developed and thoroughly diagnosed, and, in the event of it proving to be small-pox, they are sent forthwith to the hospital ships for treatment, but, if otherwise, they are dealt with in a different manner. The rooms occupied by such patients are at once thoroughly disinfected and prepared for the reception of other patients.

"In 1893 the steamers above-named conveyed no less than 10,652 passengers to and from these wharves to the hospital ships at Long Reach. Of this number 2,364 were infected patients; 2,053 were recovered patients brought back to London; and 6,235 were visitors, staff, workmen, and others. The vessels were under steam for 698 days, travelling 28,341 miles, and carrying, in addition to the passengers, about 50 tons of stores of various kinds. In 1894 the number of passengers conveyed to and from the ships was 7,614, of which 1,101 were infected patients taken to the ships, 1,009 were recovered patients returned to London; the remainder, 5,504, being visitors, staff, workmen, etc. The vessels were under steam for 880 days, and carried, besides passengers, stores weighing nearly 100 tons. This large amount of beneficent work has been carried out in the most economical and satisfactory manner—without one single mishap—by the board's superintendent, who is also a retired naval engineer officer, and has so arranged the details appertaining to the work as to render it necessary to employ, as a rule, only two crews for the whole of the vessels, and has found that to be sufficient to meet the exigencies and requirements of the river ambulance service.

"These are facts and figures which very few people are cognizant of, and show most clearly the admirable work performed by the board. They also demonstrate that measures are adopted by them by means of which the health—indeed, the very lives of the population of this great city—are protected."

Iridescent Glass.

ANY one who has visited the Metropolitan Museum of Art in Central park will doubtless remember the collection of ancient glassware there exhibited. Some have doubtless supposed that the beautiful iridescence of the glass in these exhibits was produced artificially. It is a fact that iridescent glass can be made artificially by treating the glass with chemicals and by other means, but it is also a fact that glass long exposed to the action of atmospheric influences becomes iridescent, and hence the finds of ancient glass ware in buried cities, etc., are nearly always iridescent. Mr. Charles E. Benham,

in *Engineering* (London, Oct. 9), explains the nature of iridescence, and discourses pleasantly and instructively upon this and other signs of antiquity in glass. Iridescence results from what, in the science of optics, is technically called interference. The phenomenon of interference is explained in all text-books of optics, and is easily understood. It is a result of refraction and reflection acting simultaneously, the effect being to suppress some of the ether waves in the total of white light, thus producing colored light according to the waves so suppressed. The presence of a thin transparent film produces this effect, whether the film be itself glass or some other material.

The changes which glass undergoes under the action of the elements ultimately results in its disintegration, although it is popularly thought to be, and is, one of the most indestructible of substances. When glass is buried, a thin transparent film forms upon its surface. Light is reflected from both the outer and inner surface of this film, and is also refracted in passing through it, the combined result being the suppression of some of the ether waves and the partial decomposition of the white light. The film may not be always of the same composition, but its effect in producing interference depends, not upon its chemical composition, but upon its thickness.

Iridescent glass is one of the most beautiful objects known to man. It has, therefore, been attempted, and successfully, to produce the iridescence artificially. As soap-bubbles are iridescent, so glass blown in very thin bulbs is iridescent; but, of course, this has no value on account of its fragility. Mr. Benham says that "iridescent glass which will bear handling may be made in several ways. We may have a thin film of any transparent substance on its surface, or its own substance may be so laminated that the upper layers produce interference. The external film of some foreign substance comes in many different ways. It is not uncommon to see a glass water-bottle that has stood disused for a long while tinged with red and purple iridescence from a thin film of salts on its inner surface, deposited probably by the water which has been inside it, and so tightly will this film cling that it is not always easy to get rid of it. But, when glass has lain exposed to the elements, and especially in damp soil, a film, composed, according to Péligot, of silica and earthy silicates, gradually forms over it and gives a much more brilliant iridescence, accompanied with a silvery glistening. This film does not appear always to be derived from the glass, for, when it is scraped off, which is accomplished with difficulty, it is often found that the surface beneath it is still quite smooth and polished. The deposit is probably derived from the rain, which is impregnated with a certain quantity of silica derived from the soil over which it runs. But, when the exposure to the elements has continued still longer, the glass itself begins to undergo change. Its surface, when viewed under the microscope, after the removal of the external film, is dotted all over with tiny excrescences, like little bubbles of glass. Acids which cause the external film to flake off easily, by dissolving the silicates, do not affect the glass excrescences below, which glow with rich deep colors, generally much darker than those of the glistening external coating. With greater age the uneven character of the glass surface is much more marked, and a microscopic examination of the various stages of change suggests a rough and ready method of computing the antiquity of the glass, though, of course, modifying influences may prevent exact accuracy being arrived at in this way.

"The greatest sign of extreme antiquity is probably the lamination of the glass, which may often be seen to be split into layers parallel with the surface, like mica or selenite, and in some cases ancient glass vases, when unearthed, have entirely split up into mere flakes. It is easy to see how the lamination causes iridescence on the principle of interference by thin films, and the preceding stage of minute hemispherical bubbles would, of course, produce the same effect, though Mr. Wallace-Dunlop, in his 'Glass in the Old World,' says that the light is 'cylindrically de-

polarized as it were,' whatever that may mean.

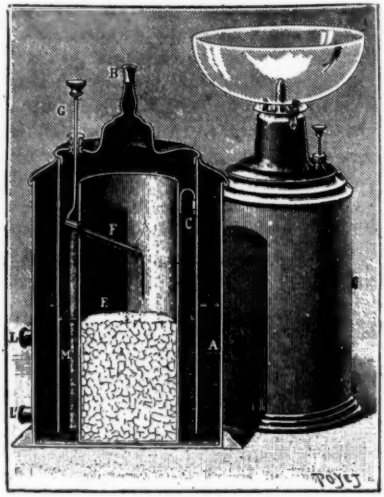
"It appears that white glass is less easily acted upon than the colored varieties, and, according to a writer in the 'Encyclopædia Britannica,' alkaline varieties are specially affected. Sir David Brewster expresses himself very poetically when he says of this 'disintegrated' glass that 'there is perhaps no material body that ceases to exist with so much grace and beauty when it surrenders itself to time, and not to disease.' As to the causes of the changes which glass undergoes in course of time, every authority adopts the supposition that there is a chemical action. Rood says that some of the alkali appears to be removed by the rain. Numerous writers refer to the apparent influence of ammonia, as evidenced by the alleged special tendency of glass in stable windows to become iridescent."

Mr. Benham evidently does not think the chemical theory accounts well for all the facts. He rather inclines to the belief that iridescence of ancient glass results from a long series of changes in temperature; but this theory will be harder for most people to accept than the chemical theory. Passing from theory to what has been done in the manufacture of iridescent glass, it is said that thin films of silicate of soda deposited on glass produce iridescence, but fail to gain the gorgeous effects of the ancient specimens. Some approximation to these effects has been obtained by M. Brame by the use of hydrofluoric acid and fluorid of calcium. M. Meunier found that fumes from volcanic ashes would render glass iridescent. The patented process discovered by M. Frémy and M. Clémandot produces beautiful effects, but does not well imitate the antique glass. The effects are gained in this process by the combined action of heat, pressure, and weak acids.

A Simple Acetylene Lamp.

THE illustration of this new lamp is reduced from *La Nature*, from which also is derived the following condensed description. The lamp is, presumably, of French devising. It is so easy to construct that almost any worker in sheet metals could make one, but it ought not to be made of copper or brass.

An external receptacle, A, is provided at one side with two apertures closed by screw plugs, L and L'. Within this there is a cylinder suspended by its upper part and not reaching the bottom of the receptacle, A. In the center there is another cylinder, D, closed at the bottom and open at the top. The cover of the apparatus is provided at B with a fishtail burner, and at G with an aperture to permit of the passage of a vertical rod. The carbid of calcium is placed in E. At F there is a nearly horizontal rod that supports a wick whose



ACETYLENE LAMP.

lower extremity is immersed at M in the water that has been introduced into the external cylinder. The rod, G, permits of displacing the rod, F, through simple pressure.

When the lamp is filled, it suffices to raise the rod, G, when the water absorbed by the wick will ascend through capillarity and fall drop by drop upon the carbid. The acetylene gas immediately produced is lighted at the burner, B. In order to arrest the operation of the lamp, it suffices to lower the rod, G, when the rod, F, will immediately rise, and the water will no longer fall.

In order to prepare the lamp, it is neces-

sary first to remove all the internal parts, screw up the plugs, L and L′, and fill with water to a level slightly above the first aperture when all the parts are in place.

The central cylinder is afterward charged with carbid up to a certain height, taking care that the wick shall not be in too close proximity. All the internal parts are then replaced, and the cover is put on. The regulating rod is lowered, and the lamp is ready to operate.

Before setting the lamp in operation, it is necessary to make sure that the plugs are well screwed in, and that the rod, F, is in condition to move freely. The intention is to consume the gas as fast as it generates,—not to accumulate a store of gas for future use.

Purification of Acetylene.

IN a lecture given at Liege by the famous Professor Raoul Pictet, of Geneva, he stated a method whereby the impurities contained in commercial acetylene may be safely and entirely removed. When pure, the combustion of this gas generates the most powerful artificial light known to man. He exhibited candelabra, each having nine burners, and consuming nine and one-half feet of pure acetylene gas per hour, with which, in comparison, the electric light seemed a pale illumination.

In its impure state this gas is dangerous. Its impurities attack the metals, especially copper; and the salts thus formed are transformed into explosive acetylene of copper. Acetylene itself, an endothermic substance, has a tendency to explode, if its impurities permit of molecular change. Professor Pictet, however, here takes advantage of the law as to critical temperatures, by virtue of which all chemical reaction, even the most active, may be arrested by a sufficient degree of cold; and he showed that sodium—which burns spontaneously on the simple contact of water—is uninfluenced by hydrochloric acid when cooled down to about 60 deg. below zero Cent., although it is attacked when the temperature is raised to 50 deg. below zero Cent. In the same manner acetylene is uninfluenced by sulphuric acid at 50 deg. below zero Cent., while all its impurities are arrested by that acid at the same temperature; and this physico-chemical filter thoroughly refines acetylene, while rendering it liquid and inoffensive. In this state the gas is stored in nickelized steel cylinders, and a small gasometer permits of its expansion and immediate utilization, the illuminating power being fifteen, twenty, thirty, and even forty times that of ordinary lighting gas.

Damage by Lightning.

THE director of the statistical office in Berlin has stated, says *Public Opinion*, that damage to property and loss of life by lightning are unmistakably increasing. It has been shown that in Bavaria the fires due to lightning increased from a yearly average of thirty-two in 1833 to 1843 to one hundred and thirty-two in 1880 to 1882, while the number of persons struck by lightning and of those killed rose from one hundred and thirty-four and seventy-three respectively in 1855 to one hundred and eighty-six and one hundred and sixty-one in 1885. The causes assigned for the increase are the employment of electricity in various industries, the continual change of form of the earth's surface by deforestation, drainage, etc., and the impurities introduced into the atmosphere by the growing consumption of coal.

This category of causes, the potency of which is problematical, leaves out of account a cause whose influence cannot be doubted,—namely, the increasing density of the earth's population. Considering the earth as a target for a fixed annual number of lightning strokes, the settling of unoccupied lands and the multiplication of structures distributed over the surface must increase the number of casualties. If on every square yard in any region of the earth's surface there stood a man, every lightning stroke in that region would result in injury or death to a human being.

Multiplication of buildings must have the same effect upon fires caused by lightning; and it would seem that the number of fires thus caused ought to increase very nearly as the area covered by buildings not fire-proof.

Aluminum Cooking Utensils.

THE present status of aluminum as a material for cooking utensils was stated in a paper read before the recent congress of applied chemistry by Mr. Boroma.

"The utility of an aluminum dish, in respect to its fitness for culinary vessels, depends on the purity of the metal. A pure aluminum dish is almost, if not quite, as resistant to solvent effects of ordinary foods as any common metal. The impurties which do the most harm are sodium and carbon. When the aluminum contains carbon, an electric current is at once set up when a suitable liquid is applied. In such cases, after water, especially if it be saline, has stood in the dish for one or two weeks, the surface will be found dotted with brilliant rings, and, on scraping off the aluminum, the particle of carbon will be disclosed. If a strong solution of salt be used, the action may be sufficient to cause a perforation of the metal. The aluminum of commerce, unfortunately, is not very pure, and it is for this reason that so many aluminum dishes have shown a rapid deterioration. The French troops in Madagascar have been supplied with fifteen thousand sets of aluminum dishes, and, when a soldier has to carry his kitchen with him, the importance of lightness is not to be despised. But, even granting that in cooking in aluminum dishes a small amount of alumina is introduced into the food, it has not been shown that it exercises the least harmful action on the digestion. The experience of two men may be cited who lived for a year on food prepared exclusively in aluminum dishes without the slightest impairment of their health."

Possibilities of Beet Sugar in the United States.

MR. HERBERT MYRICK, of Springfield, Mass., has written a letter to *Bradstreet's* on the subject of beet-sugar production, in which he expresses belief in the possibility that the United States might profitably produce all the sugar it consumes. The desirability of such a consummation will be admitted in view of the fact that more than $100,000,000 are annually paid in this country for imported sugar. Yet, there is already a large amount of domestic beet-sugar produced. California leads in the industry, but Utah, New Mexico, Nebraska, and Wisconsin are coming into line, and the experiment stations of other States have proved, and are proving, that the profitable cultivation of sugar beets may be instituted in many other localities. About 300,000 tons of domestic beet sugar are now produced, while nearly 2,000,000 tons are imported.

The beet crop is said to be attended with no waste whatever. After the juice has been expressed, the remaining parts of the plant, including the tops, are stated to be nutritious food for cattle, and to favor a yield of milk from cows. As sugar contains nothing but carbon, oxygen, and hydrogen, the growth of beets ought not to impoverish land when the utilization of the roots and tops by feeding cattle upon the land producing the beets is carried out.

The following points are named as important to investors in the consideration of projected beet-sugar enterprises.

First. The factory must be assured of a certain supply of beets of good quality. Even if pledges of an abundance of beets are forthcoming, they are of little value, unless it has been determined by actual experiment upon the lands in question that they will produce beets of proper quality as well as quantity. At least two or three years' tests are usually necessary to determine this beyond a doubt. Fortunately, such tests have been made already in a large number of places. Too much stress cannot be laid on getting plenty of rich beets.

Second. The beets should be grown as near the factory as possible; a haul of fifty to a hundred miles absorbs much of the profit on the crop. There should be sufficient beet land available within reasonable distance to furnish the desired quantity of beets when only one-third of such land is sown to beets, thus permitting a wise rotation of crops. Beets can be grown year after year on the same land, but it is not good agricultural practice.

Third. A successful factory requires an

almost unlimited supply of pure water, good and cheap lime, also fuel, while facilities for getting the sugar to market are important.

Fourth. The best talent and the best machinery are the cheapest in starting or operating a sugar factory.

These and other points properly looked after by experts, and over-capitalization avoided, a beet-sugar factory, with good business management, under appropriate national and State encouragement during the first few years, will prove a safe and profitable investment.

Paraguayan Timber Woods.

CONSUL SAMUEL W. THOMÉ sends from Asuncion an account of the woods obtainable in Paraguay, his communication being published in *Consular Reports* for October.

The export of cedar wood from Cuba to Europe has ceased, partly on account of the Cuban rebellion, and partly because the supply of cedar has been nearly exhausted. According to Mr. Thomé, Paraguayan cedar is likely to take its place. He does not rank it as fully equal to the Cuban cedar, but says it is, nevertheless, of good quality, both in color and texture.

It appears that Paraguay is a habitat of a considerable variety of trees whose wood possesses valuable qualities. Some of those most highly spoken of are petereby-negro, black palm, espanillo, curupay, tatana, guayabi, palo santo, quebracho negro, quebracho blanco, lapacho, bitter iviviraro, iviviraro-mi, incienso, and palo blanco. These are selected from a list of some twenty named by Mr. Thomé because of their valuable properties.

The petereby-negro is one of the best woods produced in the world. It is an excellent mast timber, and can be obtained in pieces of great length. It takes a fine polish, makes handsome furniture, and is very durable, light, and odoriferous. It resembles American walnut in color, but can be obtained with a wavy grain.

The black palm is also spoken of as a first-class wood. It is, however, very hard. It makes excellent veneers, is susceptible of a high polish, and under water or under ground is said to be practically everlasting.

The wood of the espanillo has qualities so lasting that small sticks of two to three inches in diameter remain sound under ground for forty or fifty years.

Curupay is an excellent pile timber for docks and bridges. It is also in demand for sleepers, and its bark is used for tanning. Tatana is a hard, handsome, yellow wood, also good for sleepers, and used by ship-builders for shoulder and stern-posts. It appears to be one of the best woods for many purposes. Guayabi is a tough, flexible, elastic wood, used for bullock yokes, axe-handles, etc., and said to be superior to American hickory.

Palo santo is a beautiful wood for fancy turning. Quebracho negro is ranked as "the king of hard wood." "*Quebracho*" signifies "axe-breaker." It is used for tanning, and its durability in earth or water is exceeded by no other timber. Quebracho blanco has the properties of quebracho negro, except that it is of no use for tanning.

Lapacho is a greenish-yellow wood of great strength, and does not crack or split easily. It is largely used for ship-building and railway purposes, but does not last well in damp soil. A curled variety is spoken of as making beautiful furniture. It is a highly inflammable wood.

The bitter iviviraro resembles oak in appearance, does not crack, is always sound in the heart, and is a valuable timber. The natives make cart-wheels of it, which they use without tires. It is said to be easily worked and excellently adapted to ship-building carpentry and carriage-building. Iviviraro-mi is a highly-prized wood, used for engraving blocks. Incienso is used for parquet flooring, on account of its odor and durability. Palo blanco is a tall tree, furnishing a wood stated to be practically everlasting against wind and weather. It is easily worked. Borers never attack it, and it is not subject to dry rot.

THE production of coal in India is steadily increasing. In 1885 there were mined 1,295,000 tons, while last year the figures were increased to 3,167,000 tons. The

Bengal collieries are responsible for about two and a half millions of the total. Much attention has also been paid of late years to the discovery of mineral oil wells, but the success attained has not been encouraging so far, though some 36,000 gallons of oil were obtained from the Digboi field in 1895. The boring at Sukkur has failed to reach an oil bed, though it has been carried to a depth of 1,500 feet, and is to be sunk 200 feet further before being abandoned.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

8687. Cost of European Geological Surveys. E. A. Schneider (Part first considers the work as carried on in Russia and Germany). Eng and Min Jour—Oct. 10. Serial. 1st part. 2000 w.

8719. Address by the President of the British Association for the Advancement of Science (J. J. Thomson's address at the Liverpool meeting beginning Sept. 16. A general review of progress during the year in mathematics and physics). Sci Am Sup—Oct. 17. 5800 w.

*8767. The Phonograph (Illustrated description of the most modern phonograph and its possible future). Engng—Oct. 9. 2500 w.

*8768. Iridescent Glass. Charles E. Benham (Cause of iridescence. How produced by atmospheric influences, and artificial imitations of these effects). Engng—Oct. 9. 2000 w.

†8830. Valuable Woods of Paraguay (Twenty different woods are named and their characteristics and industrial uses specified). Cons Rept—Oct. 1500 w.

†8831. Transportation of Butter in Refrigerator Ships (Danish Government tests of artificial refrigeration and its effects upon butter shipped on vessels from Copenhagen to Leith). Cons Rept—Oct. 2000 w.

†8832. Refrigerated Meat Trade of Australasia (Statistics and other information showing the extent of the trade and its effects upon the world's market for food supplies). Cons Rept—Oct. 2000 w.

†8833. Refrigerated Meat Industry of Victoria (The refrigerating methods employed, extent of the business and other particulars). Cons Rept—Oct. 2400 w.

†8834. Beet Sugar Industry of France (The present state of the industry, with tabulated statistics. Possibilities of beet culture in the United States). Cons Rept—Oct. 2500 w.

*8861. The Technical Education of Artisans (Address before the students of the Liverpool School of Science, Technology and Art, by W. H. Preece. The awakening in England to the value of technical education, the progress already made and necessities and duties of the future are the topics treated). Eng, Lond—Oct. 9. 1800 w.

8886. The Beet Sugar Industry and Its Prospects. Herbert Myrick (The present prosperous condition of the industry, its possible large extension in the United States and essentials to its success are pointed out). Bradstreet's—Oct. 24. 2000 w.

*9000. Acetyline as an Explosive (A timely account of explosions and accidents with acetyline, which emphasizes the care needed in handling this material). Eng, Lond—Oct. 23. 1800 w.

†9014. The Animal as a Machine. Robert H. Thurston (The length and breadth of the most attractive, yet most tantalizing problem yet presented to man and yet wholly unsolved is here set forth. The conclusion is that muscular energy, whatever it may be, is not thermodynamic). N Am Rev—Nov. 4500 w.

9074. Wealth Based Upon Elastic Gum. Hawthorne Hill (The rubber industry is described in a general popular style, giving many points of commercial interest). Sci Am Sup—Nov. 7. 2400 w.

†9084. The Elective System in Engineering Colleges. M. E. Wadsworth (Presents particulars and points out the conditions under which this system might with advantage be introduced more generally). Am Geol—Nov. 2800 w.

*9099. The Origin of Waves of Light. W. Wedding (The frequency and rate of transmission of ether waves which manifest themselves upon the retina as light of different colors. Differences between solar and artificial illumination. Abstract of paper read before the German Assn. of Gas and Water Engs.) Jour Gas Lgt—Oct. 27. 1500 w.

9105. The Chemical Industry and Technical Teaching (Argument favoring the introduction of industrial chemistry among the branches taught in high schools. The experiences of Germany in the beneficial effect of such teaching is cited). Eng and Min Jour—Nov. 7. 1000 w.

†9110. Edwin Marcus Chaffee as a Rubber Inventor (Biographical account, with description of inventions). Ind Rub Wld—Nov. 10. 2000 w.

†9111. Pure Rubber the Weak Point in Bicycle Tires. Gustav Heinsohn (An explanation of the cause of deterioration and the care needed). Ind Rub Wld—Nov. 10. 1500 w.

*9149. Considerations on Painting. Russell Sturgis (Review of book by John La Farge. Lectures given in the year 1893 at the Metropolitan Museum of New York. Many illustrations and the highest praise). Arch Rec—Oct.-Dec. 4000 w.

BOOKS OF THE MONTH

Descriptive Circulars containing full information relative to books herein named may be obtained of the publishers.

Goodwin, H. B. Azimuth Tables for the Higher Declinations (Limits of Declination 24° to 30°, both inclusive) Between the Parallels of Latitude 0° and 60°: With Examples of the Use of the Tables in English and French. Longmans, Green & Co., New York. 1896. Cloth, $2.50.

Lawler, Ja. J. American Sanitary Plumbing. Excelsior Publishing House (T. Carey & Co.). New York. 1896. Cloth, $2.

Bell, G. J. A Practical Treatise on Segmental and Elliptical Oblique or Skew Arches. Spon & Chamberlain, New York. 1896. Cloth, $8.40.

Glover, J. Formulæ for Railroad Crossings and Switches. Spon & Chamberlain, New York. 1896. Cloth, $1.

Merriman, Mansfield, and Woodward, Robert. Higher Mathematics. A Text-Book for Classical Schools and Engineering Colleges. Importers, John Wiley & Sons, New York. 1896. Cloth, $5.

Dana, C. A. Proudhon and His "Bank of the People." B. R. Tucker, New York. 1896. Paper, 10c.; leatherette, 25c.

English, Vincent J. Navigation for Yachtsmen. Importers, Charles Scribner's Sons, New York. 1896. Cloth, $7.20.

Kidder, F. E., C. E., Ph. D. Building and Superintendence, Part I. Masons' Work. William T. Comstock, New York. 1896. Cloth. $4.

Birkmire, William H. The Planning and Construction of American Theaters. William T. Comstock. New York. 1896. Cloth. $3.

Du Bois, H. The Magnetic Circuit in Theory and Practice. Translated by Dr. Atkinson. Longmans, Green & Co. New York. 1896. Cloth. $4.

Ferguson, L. A. Electrical Engineering in Modern Central Stations. University of Wisconsin, Madison, Wis. 1896. Paper. 35 cents.

Metcalf, W. Steel: A Manual for Steel Users. J. Wiley and Sons. New York. 1896. Cloth. $2.

Edison, T. F., and Westinghouse, C. J. The Mechanics' Complete Library of Modern Rules, Facts, Processes, etc. Revised Edition. Laird Lee. Chicago. 1896. Cloth. $1.

Graham, J. An Elementary Treatise on the Calculus for Engineering Students. Spon & Chamberlain. New York. 1896. Cloth. $2.

Judson, Isabella Field. Cyrus W. Field; His Life and Work. Harpers. N. Y. 1896. Cloth. $2.

Rix, E. A. and Chodzko, A. E. A Practical Treatise on Compressed Air and Pneumatic Machinery. G. Webb Alexander. San Francisco. 1896. Leather, pocket-book style. $4.

Bulfinch, Ellen Susan. The Life and Letters of Charles Bulfinch, Architect. With Introduction by C. A. Cummings. Houghton, Mifflin & Co. Boston. 1896. Cloth. $5.

Waring, George E. Modern Methods of Sewage Disposal for Towns, Public Institutions, and Isolated Houses; 2nd revised edition. D. Van Nostrand Co. New York. 1896. Cloth. $2.

Sternberg, G. M., M. D. A Text-Book of Bacteriology. W. Wood & Co. New York. 1896. Cloth. $5.50. Sheep. $6.50.

Barter, S. Manual Instruction: Drawing. The Macmillan Co. New York. 1896. Cloth. 80 cents.

Maycock, W. Perren. Electric Lighting and Power Distribution. The Macmillan Co. New York. 1896. Cloth. $1.75.

BOOKS RECEIVED.

The Street Railway Publishing Co., New York. American Street Railway Investments. Annual Supplement to the Street Railway Journal. 1896. Cloth, $3.

Mattice, Asa M., late of the engineer corps U. S. N. Queer Doings in the Navy. A letter from an ex-naval officer to Hon. Francis Wilson.

Benzenberg, C. H. Annual Report of the Board of Public Works of Milwaukee, for the year ending December 31, 1895.

Crehore, Albert Cushing, and Squier, George Queen. Experimental Determination of the Motion of Projectiles Inside the Bore of a Gun, with the Polarizing Photo-Chronograph. Reprinted from the Journal of the United States Artillery, Vol. V., No. 3.

Shedd, J. Herbert. Annual Report of the City Engineer of the City of Providence for 1895.

Waring, George E., Jr. A Report on the Final Disposition of the Wastes of New York by the Department of Street Cleaning. 1896.

Windsor, H. Editor. Street Railway Law. A Digest of Important Decisions Covering the More Important Class of Cases Which Occur in the Management of Street Railways. Windsor & Kenfield Publishing Co. Chicago. 1896. Cloth, $2.

Hertz, Heinrich. Miscellaneous Papers. With an Introduction by Prof. Phillip Lenard. Translated by D. E. Jones, B. Sc. and G. A. Schott,

B. A., B. Sc. The Macmillan Co., 66 Fifth Avenue, New York. 1896. Cloth, $3.25.

U. S. Consular Reports, June, 1896. Commerce, Manufactures, etc.

Gerdtzen, G. Adolph. (Bulletin of the University of Wisconsin). The Problem of Economical Heat, Light, and Power Supply for Building Blocks, School Houses, Dwellings, etc. Madison, Wis. Published by the University. 1896. Paper, 45 cents.

Tenth Annual Report of the Commissioner of Labor. 1894. Strikes and Lockouts. Vol. I. Washington. Government Printing Office. 1896.

Hale, R. S. Circular No. 5 of the Steam Users' Association. Report on European Practice. Steam Users' Association, Boston. 1896.

Twentieth Year-Book of the New York State Reformatory; Year ending September 30, 1895. With Illustrations and Anthropomorphic Tables. New York State Reformatory, Elmira, N. Y. 1896. Paper.

Brough, Bennett H., Editor. Journal of The Iron and Steel Institute. Vol. XLIX. E. & F. N. Spon, London-New York. 1896. Cloth.

Exports Declared for the United States Returns from Consular Districts for Quarter ending March 31, 1896. Government Printing Office, Washington, D. C. Paper.

Consular Reports, Aug., 1896. Commerce, Manufactures, etc. Government Printing Office, Washington, D. C. Paper.

Mayor's Message, City Controller's Report, and Reports of Departments of the City of Williamsport, Pa., for the Year 1895. Also Certified Ordinances. Gazette and Bulletin Printing House, Williamsport, Pa. 1896. Paper.

Ninth Annual Report of the Board of Public Works, City of Duluth, For the Year Ending February 29, 1896. Paper.

Keating, E. H., City Engineer. Annual Report of the City Engineer of Toronto for 1895. Caswell & Co., Toronto, 1896. Paper.

Transactions of the American Institute of Mining Engineers. Vol. XXV. February, 1895, to October, 1895, inclusive. American Institute of Mining Engineers, New York.

Twenty-First Annual Report of the Board of Commissioners, Department of Parks, Boston, Year Ending January 31, 1896.

Wilkinson, H. D. Submarine Cable Laying and Repairing. The D. Van Nostrand Company. New York, 1896. Cloth. $5.

Commercial Relations of the United States with Foreign Countries, During the Years 1894 and 1895. Vol. II. Government Printing Office, Washington, D. C. 1896.

Kidder, F. E. Building Construction and Superintendence. Part I,—Mason's Work. William T. Comstock. New York. 1896. Cloth. $4.

Sachs, Edwin O., and Woodrow, Ernest A. E. Modern Opera Houses and Theatres. Vol. I. Royal Quarto, 100 plates, and 100 diagrams. B. T. Batsford, 94 High Holborn Street, London. 1896. Buckram, gilt. £15 15s.

Bowers, George. Twenty-Third Annual Report of the Lowell Water Board for 1895. Lowell Water Board, Lowell, Mass. Cloth.

The Cornell University Register, December, 1895. Published by the University, Ithaca, N. Y. Paper.

Balch, Lewis. A Manual for Boards of Health and Health Officers. Banks & Bros. New York. 1896. Cloth. $1.50.

Clerk, Dugald. The Gas and Oil Engine. J. Wiley & Sons, New York. 1896. Cloth. $4.

Knight, J. H. Notes on Motor Carriages, with Hints for Purchasers and Users. Imported by Charles Scribner's Sons. 1896 Cloth. $1.

Appleby, C. J. Illustrated Handbook of Machinery. Spon & Chamberlain. New York. 1896. Cloth. $1.50.

Denton, E. Barley. Sewage Purification Brought up to Date. Spon & Chamberlain. New York. 1896. Cloth. $3.

Newman, J. Metallic Structures,—Corrosion and Fouling, and Their Prevention. Spon & Chamberlain. New York. 1896. Cloth. $3.50.

Schlich, W. Manual of Forestry. Imported by Charles Scribner's Sons, New York. 1896. Five Volumes: Vol. 1, $3; Vol. 2, $4.20; Vol. 3, $5; Vol. 4, $5; Vol. 5, $6.

Gerhard, William Paul. Theater Fires and Panics; their Causes and Prevention. John Wiley and Sons, New York. 1896. Cloth. $1.50.

Elliott, W. H. Block and Interlocking Signals. Locomotive Engineering, New York. 1896. Flexible Morocco. $3.

Sturgis, Russell. European Architecture: A Historical Study. The Macmillan Company, New York. 1896. Stamped Binding. $4.

Nichols, Edward L., and Franklin, William S. The Elements of Physics: A College Text-Book. In three volumes. Vol. II. Electricity and Magnetism. The Macmillan Company, New York. 1896. Cloth. $1.50.

Jackson, Dugald C., and Jackson, John Price. Alternating Currents and Alternating Current Machinery. The Macmillan Company, New York. 1896. Vol. II. Cloth. $3.50.

Miller, M. K. Annual Report of the Superintendent of Streets to the Board of Public Works of the City of Oakland, Cal., for the Year Ending June 30, 1896. Paper.

Circular No. 5 of the Steam Users' Association. Report of Mr. R. S. Hale on European Boilef Practices. Steam Users' Association, Boston. 1896. Paper.

Day, William C. The Stone Industry in 1895. Government Printing Office, Washington, D. C., 1896. Paper.

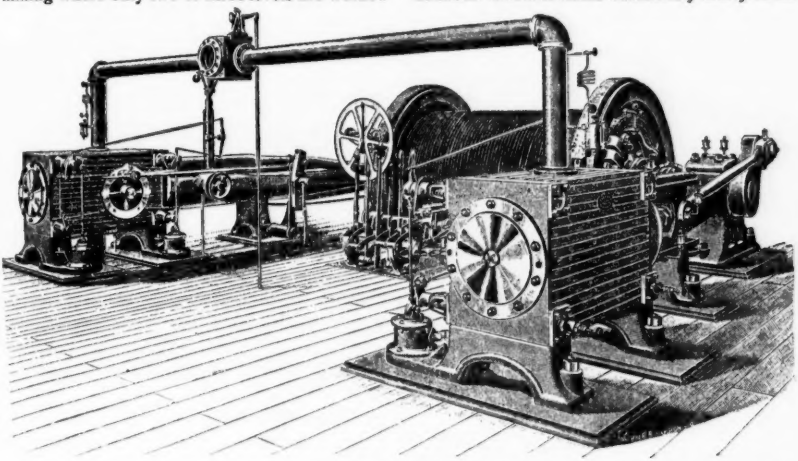
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Improved Balanced Cage Hoisting Engines.

THE accompanying illustration 2 59, shows an improved type of hoisting plant lately installed at the mines of the Aragon Mining Company, Norway, Michigan. This plant is especially adapted to handling with the greatest economy of steam, large quantities of ore from mines where the caving system is used, in which ore is only taken from two or three levels at a time, the upper levels being closed in by the caving system, as greater depth is attained. The plant is of course, equally well adapted to other metal mining where only two or three levels are worked at a time, as the mine increases in depth, or in coal mines where two or more veins of coal are worked from the same shaft.



Heretofore, the installation of a plant of first motion hoisting engines having capacity for handling independent cages, or skips, from a depth of 1200 to 1500 feet, has meant the use of independent drums for each cage, or skip, which involves large drums and powerful engines for the depth above named, and a very considerable first cost of equipment.

The improvements embodied in the plant illustrated, enable the mine operator to handle the same amount of ore with a smaller drum and smaller pair of engines, from as great a depth, and still have the highest degree of economy, inasmuch as Corliss engines are used having automatic cut-off gear controlled by governor.

The drum is constructed as follows:—For a depth of 1200 feet, the main part of the drum is made of 6 feet diameter and of sufficient face to accommodate this amount of rope, this wide part of drum being securely keyed to the main crank shaft, and fitted on left-hand side—as shown in illustration, with a brake rim 8 feet diameter which is made sufficiently heavy to answer as a flywheel, to give proper momentum to insure early cut-off of steam in the cylinders. The right hand part of drum (about 2 feet in face, giving sufficient adjustment for three levels) is loose on the shaft, but capable of being connected therewith at any moment, by a powerful clutch of the band friction type. This loose section of drum also has an 8 foot heavy brake wheel, with flywheel rim in same. By an ingenious arrangement of brake connections, the brakes may be operated simultaneously by one lever, when hoisting in balance, or the brake on fixed part of drum may be set, holding the en-

gines at any point, while the brake and the loose section is being used for lowering, for adjustment to some desired level.

The method of making adjustment is as follows:—Two hoisting ropes are securely fastened, one to each end of the drum, being of sufficient length to reach a desired depth to be attained before these ropes are worn out. The cages, or skips, are then attached to the other ends of the ropes, and the cage attached to the loose narrow part of drum is lowered to the top level to be worked. The cage attached to the fixed part of drum is then raised until at the proper landing or dumping point, when the clutch on the loose part of the drum is locked and the brakes connected so as to operate simultaneously, and the plant is ready to work in balance.

The adjustment to different levels is always made when the cage on the fixed part of drum is at the dump, as the rope attached to other end of drum is nearly unwound, the cage, or skip, being in the shaft, so that the loose part of drum can be instantly loosened and dropped to any other of the working levels. The advantage of this arrangement will be readily seen, as substantially one drum is used for winding both ropes, one unwinding from the bottom as the other winds on top. The groove is so arranged at the junction of the two sections of the drum, that there is no trouble in the rope running from the narrow section to the wider one.

The successful working of the plant at the Aragon Mine fully demonstrates the practicability of this new system, which should be of interest to all operators of mines having large bodies of ore to be handled cheaply, or to coal miners having more than one seam of coal to be worked, as it insures them a first class high grade plant as regards economy, with the lowest degree of first cost.

The new points on this plant are fully covered by application for patents now pending, by the designers and builders who are the well-known Webster, Camp & Lane Machine Company, of Akron, Ohio.

The Durability of Rubber Tiling.

FOR some time past, the New York Belting & Packing Company, Ltd., has been manufacturing Interlocking Rubber Tiling, and they have recently taken orders for three prominent hotels in New York City, a well-known club in Cincinnati, 32 dining and sleeping cars, one steam-ship and one U. S. battle ship. The first lot of tiling laid was in the Broad Street Depot of the Pennsylvania Railroad in Philadelphia. After two and one-half years, with an average of 50,000 people passing over it each day, a careful test with a straight-edge shows the tiling to have worn down only $\frac{1}{16}$ inch, and that only in spots where nine-tenths of the passing is concentrated. Not a cent has been spent for repairs since it was laid.

A Large Drying Plant.

THE Buffalo Forge Co., Buffalo, N. Y., recently received an order for an apparatus to be used for what is probably the largest glue dryer in the world. It involves the use of 3 steel plate fans, 170" tall, having inlets 79" in diameter, outlets 63½"×70" wide. The wheels inside the fan casings are 120" diameter × 66½" wide at periphery. Each one of these fans is driven by a 12×14 Horizontal Self-Contained Center-Crank Engine of the Buffalo Forge Co.'s make. Each fan will deliver at its outlet 150,000 cu. ft. of air per minute at 1 oz. pressure. Each is to be supplied with a heater of appropriate size. When it is taken into consideration the combined capacity of these fans is 450,000 cu. ft. of air per minute, it may at once be seen that the size of the glue dryer is, undoubtedly, the largest one ever erected. The outfit will be installed in the works of Delaney & Co., Philadelphia, Pa., under the specifications of Francis Bros. & Jellett, the well known engineering firm of that city.

Air Brake and Signal Hose.

ON many railroads it is the practice to take ordinary air brake hose and paint it red for use in connection with the train signal system. It is a well known fact that paint is injurious to all kinds of rubber goods, as the oil in the former has a tendency to soften and crack the outside of the latter.

To overcome this objection the Boston Belting Co., Boston, introduced their Red Signal Hose, the distinctive features of which are its natural red color and a peculiar rough surface which enable the train men to instantly distinguish the signal from the air brake hose either night or day.

The Red Signal Hose has been very highly commended by all railway officials who have seen it, and it is in use on quite a number of the leading systems.

A Compressed Air Pumping Plant.

COMPRESSED AIR is revolutionizing the means of moving large quantities of water economically and easily for water works, irrigation pur-

poses, etc. Air-compressing machinery is now made of any desired capacity, to be operated by water, steam, electric, or gasoline engine power direct, or by any belt power already established. The fact that the well is very deep or does not quite flow, or that inexhaustible water can be procured in shallow, open wells makes no difference, as the principle can be applied by some one of the various systems to harmonize with all conditions. The illustration here shown is made from a photograph taken at the 10" artesian well of the Bell Waterworks Co., at Waco, Tex. The well naturally has a flow of 290 gallons of water per minute at the surface; the compressed air increases the flow to 679 gallons per minute, as shown in the illustration, giving over 550,000 gallons of water per day more than the original flow. This is only one of the large number of plants erected to the perfect satisfaction and profit of the purchaser in this country. This method is used to operate one well, or two or more wells can be operated simultaneously, from a central plant.

Water is obtained from artesian wells whose natural rise is several hundred feet below the surface, and elevated into tanks at various elevations above the surface. Air is sent several miles for bringing water from lakes, rivers, springs, etc., to factories and waterworks that are located for the convenient reception of the fuel supply. The care and maintenance of an air system for bringing water is much less than that of a pump.

The American Well Works' (Manufacturers, Aurora, Ill.) special claims for this principle are:

(*a*) Greatly increasing the output or natural flow of artesian wells.

(*b*) Causing non-flowing wells to flow.

(*c*) Moving large quantities of water on or above the surface.

Thus without increased expense for a new well the desired increase of water can be in nearly all cases secured; with clear discharge pipe, no wearing parts, roily as well as clear water can be moved without detriment to the plant.

This great efficiency has only been obtained by persistent application of their skillful engineers, and by costly experimenting.

AFTER COMPRESSED AIR WAS APPLIED.—INCREASE OF FLOW FROM 290 TO 679 GALS. PER MINUTE.

A Notable Transmission Plant.

BOTH on account of amount of power and distance of transmission a contract placed with the General Electric Company by the Pioneer Electric Power Company of Ogden, Utah, is most notable. The contract covers a complete 5000 h. p. three-phase plant, with a transmission of 36 miles from a fall in the cañon of the Ogden River, almost within the limits of the city of

Ogden. Across the head of the Ogden Cañon a dam will be thrown, forming an immense storage reservoir covering some 15 or 20 square miles. The power-house will be nearly six miles from the dam, the water being carried through a six-foot wood pipe about five miles, and the rest of the way through a six-foot pipe of rivetted steel, both pipes fitted at intervals with automatic relief and air valves to prevent bursting or collapsing under varied flow caused by changes of load. At the power-house the effective head will vary from 400 to 450 feet. The full capacity of the pipe-line will be 10,000 h. p.

Of two duplicate receivers at the power-house either can be shut down without stopping the plant; and to pipes running from these the water-wheel nozzles will be connected. Speed will be controlled by Knight governors, and the valves will be operated by hydraulic pistons so that the generators may be stopped and started from the switchboard. The discharged water from the wheels will be used for irrigating some 18,000 acres of land in the vicinity of Ogden, which will be reclaimed for farming purposes.

The electric plant at first will consist of five 1000 h. p. 24-pole three-phase generators driven by Knight water-wheels running at 300 revolutions per minute, supplied and fitted by the Risdon Iron & Locomotive Works, of San Francisco. The water-wheel and armature are mounted on the same shaft, and are supported by the same base-frame and bearings. The current is to be 60 cycles per second and the generators will be wound for 2,300 volts.

Two 100-K. W. exciters, directly connected to their own water wheels will be provided, either of which will excite the fields of all the generators in the station. The current from the generators will be carried by covered cables laid in ducts between the generator foundations and the wall of the building, to the generator switchboards, which will be of blue Vermont marble panels completely equipped with all the necessary controlling, regulating, and indicating appliances.

Nine 250-K. W. step-up transformers and the 2,000- and 15,000-volt feeder-panels will be placed in a gallery over the generator switchboard, and will raise the generator potential from 2,300 volts to 15,000 volts, at which pressure 2,000 h. p. will be transmitted to Salt Lake City. Local distribution of the balance at Ogden will be made at 2,300 volts.

The transmitted current will pass over six No. 1 wires strung on insulators of a special porcelain developed by the General Electric Co., to withstand high potentials to nine 250-K. W. step-down transformers at Salt Lake City, which will deliver it at 2,300 volts for distribution.

The transmission line and transformers will be arranged to allow of the use of a potential of 25,000 volts, permitting the efficient transmission of current to the mining regions of Mercur and other camps thirty to thirty-five miles beyond Salt Lake City. All lines will be protected by the latest types of General Electric Lightning Arresters, which have proved so efficient in other transmissions.

The pipe-line contract is one of the most extensive yet undertaken. Practically all the work of the pipe-line will be done on the ground, the steel being received in flat sheets to be rolled, punched and rivetted in the shops and the lumber for the wooden pipe in the rough to be milled, planed and put together on the spot.

Salt Lake City, with the completion of the Pioneer plant, will receive power from two of the most important electrical transmission installations ever undertaken, one, that from the Big Cottonwood Cañon, only recently completed, the other that of the Pioneer Company, expected to be inaugurated about the first of November of this year.

NEW CATALOGUES AND TRADE PUBLICATIONS.

Crane Elevator Company, Chicago, Ill., U. S. A.=(a) Pamphlet illustrating and describing improvements in high pressure, high duty elevators, passenger elevators, etc. (b) Description tests, etc., of the same.

The Goubert Manufacturing Company, New York =Elegantly printed and illustrated pamphlet discussing principles, practice, and advantages of heating feed water and describing the "Goubert Water Tube" feed-water heater.

The Jeffrey Manufacturing Company, Columbus, Ohio, Denver. Colorado, and New York, U. S. A.=Daintily printed, illustrated, and bound pamphlet, illustrating and describing important installations of the Robinson Coal Washer.

The Solvay Process Company, Syracuse, N. Y., U. S. A.=Illustrated pamphlet describing the Solvay process, alkali, its various forms and uses, with notes on alkalimetry, and chemical and commercial tables.

Armstrong Bros. Tool Co., Chicago, Ill., U. S. A.=Catalogue and price-list of Armstrong's patent tool holders.

The Emerson Co., Baltimore, Md =Pamphlet illustrating and describing the "Automatic Compression Dry Kiln," and also, setting forth, the principles of, and the various systems employed in, drying lumber.